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(54) **Nonwoven fabric and process for making same**

Vliesstoff und Verfahren zur Herstellung

Etoffe non-tissée et procédé pour sa production

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Description

Technical Field

[0001] This invention generally relates to an absorbent, flushable, bio-degradable, and medically-safe nonwoven fabric suitable for use as wraps, wipes, absorbent pads, etc., and more particularly, to such fabric formed with polyvinyl alcohol binding fibers.

Background Art

[0002] In the industry of consumer disposables and medical nonwovens, the emphasis on development is being placed more and more on nonwoven fabrics that are bio-degradable, flushable, without chemicals, and medically safe, possess desired hand (softness) and aesthetic texture, and have sufficient wet strength for their use. Generally, it has been difficult to produce such fabric without using chemicals that may produce reactions in users, or without using mechanical bonding or thermal fusing methods that produce a denser or stiffer fabric or fabric that is not flushable or bio-degradable.

[0003] The use of polyvinyl alcohol (PVA) fibers in combination with other absorbent fibers for forming a flushable, bio-degradable nonwoven fabric is known in the industry. The PVA material is known to be medically safe for use in contact with skin or internal body tissues. However, untreated PVA fibers are water soluble and may result in a product that has unacceptably low wet strength. Therefore, prior attempts have used PVA fibers in relatively large amounts of 20% to 90%. However, use of a large amount of PVA fibers results in a product that lacks softness and has a paper-like feel.

[0004] Another approach has been to use PVA fibers that have been heat-treated or chemically treated for greater binding strength and stability. For example, in U.S. Patent 4,267,016 to Okazaki, a paper or fabric is formed with PVA fibers that have been treated in a solution of PVA and an adduct of polyamide condensation product and halogen-epoxy propane or ethylene glycol digylcidyl ether in order to render them boiling-water resistant when heat treated. In U.S. Patent 4,639,390 to Shoji, nonwoven fabric is formed with PVA fibers that have been heat-treated and acetalized so as to dissolve in water only at temperatures higher than 100°C or are insoluble. Although a fabric of increased strength is provided, the use of such treated, insoluble PVA fibers results in a product that is relatively stiff, not satisfactorily flushable or biodegradable, and/or not medically safe for some users.

Summary of Invention

[0005] Accordingly, it is a principal object of the present invention to provide a nonwoven fabric that possesses all of the desired properties of softness, absorbency, flushability, biodegradability, being medically safe, and having sufficient wet strength for use as wraps, wipes, absorbent pads, etc.

[0006] In accordance with the invention, a nonwoven fabric comprises from about 2% up to about 10% of untreated, water-soluble polyvinyl alcohol (PVA) fibers that are heat-bonded to a matrix of absorbent fibers such that said fabric has a wet-to-dry tensile strength ratio of at least 25% in the machine direction (MD) and cross direction (CD), and a drape softness of between 0.5 to 4.0 gmf/gsy (0.0041 to 0.0328 N/gsm) in the MD and 0.1 to 0.5 gmf/gsy (8.2×10^{-4} to 4.1×10^{-3} N/gsm) in the CD.

[0007] An especially preferred range for the PVA fibers is from about 4% to about 8% per dry weight of fabric. The use of the low amounts of PVA fibers provides an excellent combination of softness and wet strength. The preferred absorbent fibers are cellulosic fibers such as rayon and cotton. Synthetic fibers such as acetate, polyester, nylon, polypropylene, polyethylene, etc., may also be used.

[0008] The invention also encompasses a method for producing nonwoven fabric having PVA binding fibers, comprising the steps of: blending untreated, water-soluble PVA fibers with a matrix of absorbent fibers; carding the blended fibers onto a moving web; adding water to the web in an amount sufficient to soften the PVA fibers for binding to the absorbent fibers while maintaining sufficient web integrity; heating the wetted web in a first stage of heating cylinders in a temperature range of about 40°C to 80°C to bind the PVA fibers to the other absorbent fibers; then further heating the web in a second stage of heating cylinders in a temperature range of about 60°C to 100°C to complete the binding of the fibers and drying of the web.

[0009] The wetting of the web can be accomplished by adding water through a water pickup station then removing excess water from the wetted web through vacuum suctioning. Alternatively, the water can be added in controlled amounts through a padder. The two-stage heating allows the PVA fibers to saturate their bonding points to the other fibers without unduly melting the PVA fibers and weakening them at the lower heating temperature, then completing the thermal binding and drying of the web at the higher heating temperature. The web may also be passed through an aperturing station for low-energy hydroentanglement to enhance the final fabric's strength and texture.

[0010] Other objects, features, and advantages of the present invention will become apparent from the following detailed description of the best mode of practicing the invention, considered with reference to the drawings, of which:

Brief Description of Drawings

[0011] Fig. 1 illustrates a process line for producing soft, absorbent, flushable, bio-degradable, medically safe, non-woven fabric with untreated polyvinyl alcohol (PVA) binding fibers.
[0012] Fig. 2 illustrates another version of a process line for producing a desired nonwoven fabric with PVA binding fibers.
[0013] Fig. 3 is a photomicrograph depicting the resulting structure of a nonwoven fabric having PVA binding fibers in accordance with the invention.
[0014] Fig. 4 is a photomicrograph depicting the resulting structure of a nonwoven fabric having PVA binding fibers that is patterned or apertured by hydroentanglement.
[0015] Fig. 5 is a bar chart comparing the PVA fiber percentage amount in the nonwoven fabric compared to weight-normalized machine-direction (MD) dry tensile strength.
[0016] Fig. 6 is a bar chart comparing the PVA fiber percentage to MD wet tensile strength.
[0017] Fig. 7 is a bar chart comparing the PVA fiber percentage to cross-direction (CD) dry tensile strength.
[0018] Fig. 8 is a bar chart comparing the PVA fiber percentage to CD wet tensile strength.
[0019] Fig. 9 is a bar chart comparing the PVA fiber percentage to MD dry softness values.
[0020] Fig. 10 is a bar chart comparing the PVA fiber percentage to CD dry softness values.
[0021] Fig. 11 illustrates the interaction of MD wet tensile strength and softness for rayon/PVA nonwoven fiber.
[0022] Fig. 12 illustrates the interaction of CD wet tensile strength and softness for rayon/PVA nonwoven fiber.
[0023] Fig. 13 is a bar chart comparing the PVA fiber percentage in apertured nonwoven fabric to MD dry tensile strength.
[0024] Fig. 14 is a bar chart comparing the PVA fiber percentage in apertured nonwoven fabric to CD dry tensile strength.
[0025] Fig. 15 is a bar chart comparing the PVA fiber percentage in apertured nonwoven fabric to MD wet tensile strength.
[0026] Fig. 16 is a bar chart comparing the PVA fiber percentage in apertured nonwoven fabric to CD wet tensile strength.
[0027] Fig. 17 is a chart illustrating the interaction between wet strength and dry softness for apertured nonwoven fabric.

Detailed Description of Invention

[0028] Referring to Fig. 1, a process line is schematically shown for producing the nonwoven fabric in accordance with the present invention. First, PVA fibers are blended with other absorbent fibers in a completely homogenized manner using appropriate blending/opening devices (not shown) and then supplied to conventional card units 11 at a carding station 10, with or without the use of scramblers for randomizing the fiber orientation. The carded fibers are transported on a card conveyor 12. A suitable amount of water (hot or cold) is then applied to the web such that the PVA fibers become softened and the web maintains sufficient wet integrity. In the process line shown, the carded web is passed through a pre-wet station 13 which is essentially a flooder wherein water from a tank is applied onto the web. The amount of water applied is controlled using a valve. The pre-wet web with softened PVA fibers is conveyed by a web conveyor 14 through a vacuum module 15 which sucks off excess water from the web, then through a padder station 16 where water from a bath is applied to the web in a controlled amount under a nip roll.
[0029] The wet web is then passed through two stages of heating and drying stations wherein it is transported around a series of hot cylinders (steam cans). In the first station 17, the hot cylinders heat the PVA fibers to a temperature in the range of 40°C to 80°C in order to soften them so that they adhere to the other absorbent fibers and bind them together, thereby imparting structural integrity and strength to the web. In the second station 18, the web is heated around hot cylinders to a temperature in the range of 60°C to 100°C in order to dry the remaining water off and complete the heat-bonding of the fibers. The two-stage heating allows the PVA fiber bonding points to be formed completely without unduly melting the fibers and weakening them. The resulting bonded fabric is then wound up at a winding station 19. The described process is found to produce excellent results for PVA-bonded absorbent fabric such as used in tampons. The following examples demonstrated fabrics suitable for this application.

Example 1: Rayon/PVA Blended Fabrics

[0030] Using the fabrication process illustrated in Fig. 1, the fiber blend was composed of 95% rayon of 1.5 denier/

filament (1.67 dtext/filament) by 40 mm length, obtained from Courtaulds Company in Alabama, USA, sold under the designation Rayon 18453; and 5% PVA fibers of 3.0 denier/filament (3.33 dtext/filament) by 51 mm length, obtained from Kuraray Company in Okayama, Japan, under the designation PVA VPB 201x51. Two card units were used, but the cold water pre-wet flooder was not used. Five sample runs were obtained using straight or scrambled web orientation and at line speeds varying from 45 to 125 feet/minute (0.229 to 0.635 meters/second). The padder used a doctor blade pressure of 40 psi (2.8×10^5 Pa), nip pressure of 40 psi (2.8×10^5 Pa), roll type of 30 cc/yd^2, (35.9 cc/m^2), and cold water mix. The steam pressure was 20 psi (1.4×10^5 Pa) around the first-stage heating cylinders and 40 psi (2.8×10^5 Pa) around the second-stage heating cylinders. The fabric had a basis weight of 15 g/yd^2 (17.9 g/m^2), width of 33 - 34 inches (83.8 to 86.4 cm), and thickness of 8 to 11 mils (0.20 to 0.28 mm). The fabric properties measured for four sample runs are shown in Table IA.

[0031] The tests showed that best results were obtained in Run #4 using a fiber blend of 92% rayon and 8% PVA. This run used scrambling of the fiber orientation on the web and a line speed of 50 feet per minute (fpm) (0.25 meters per second). Tensile strength in the machine direction (MD) and the cross direction (CD) was measured by strip test (1" x 7" sample) (2.54 cm x 17.78 cm) in grams/inch (g/in) (grams/centimeter (g/cm)) . Run #4 had the highest ratio of wet-to-dry tensile strength (33%) and the highest combined measure of wet strength for MD and CD. Run #3 had relatively poor wet strength. The drape softness was measured by the INDA Standard Test Method for Handle-O-Meter Stiffness of Nonwoven Fabrics (IST 90.3 - 92) in units of gram-force (gmf) (Newtons(N)) per 8.0 x 8.0 in.^{2} (20.32 x 20.32 cm^2) test samples (units in Table 1A are converted to gmf/gsy by multiplying by 0.05).

TABLE - 1A

RUN #	LINE SPD. fpm (m/s)	RAYN/ PVA %	DRY TENS MD STRIP gm/in (g/cm)	WET TENS MD STRIP gm/in (g/cm)	DRY TENS CD STRIP gm/in (g/cm)	WET TENS CD STRP g/in (g/cm)	HOM Soft MD STRP gmf (N)	HOM Soft CD STRP gmf (N)
1 Straight web	45 (0.23)	95/5	1371.1 (539.80)	431.3 (169.80)	59.0 (23.23)	18.2 (7.17)	21.0 (0.2059)	2.5 (0.0245)
2 Scrambld web	75 (0.38)	95/5	1121.4 (441.50)	340.5 (134.06)	167.9 (66.10)	45.4 (17.87)	24.0 (0.2354)	5.0 (0.0490)
3 Straight web	100 (0.51)	95/5	1738.8 (684.57)	213.4 (84.02)	49.9 (19.65)	13.6 (5.35)	21.0 (0.2059)	1.9 (0.0186)
4 Scrambld web	50 (0.25)	92/8	1184.9 (446.50)	417.7 (164.45)	222.5 (87.60)	63.6 (25.04)	27.0 (0.2648)	5.4 (0.0530)

TABLE - 1B -

PVA IN BLEND (%) VERSUS NONWOVEN PROPERTIES								
RUN #	Wt. gsy (Wt. gsm)	Rayon/ PVA %	Dry tens MD strip g/ in/gsy (g/ cm/gsm)	Wet tens MD strip g/in/gsy (g/cm/ gsm)	Dry tens CD strip g/ in/gsy (g/ cm/gsm)	Wet tens CD strip g/ in/gsy (g/ cm/gsm)	H-O-M Soft MD strip gmf/ gsy (N/ gsm)	H-O-M Soft CD strip gmf/ gsy (N/ gsm)
1	11.1 (13.28)	98/2	13.38* (4.40)	8.29* (2.73)	0.61* (0.20)	0.00* (0.00)	0.93* (0.01)	0.15* (0.00)
2	11.8 (14.11)	96/4	39.17* (12.89)	18.53* (6.10)	2.89* (0.95)	2.41* (0.79)	1.99* (0.02)	0.27* (0.00)
3	15.2 (18.18)	92/8	105.66* (34.78)	30.44* (10.02)	11.12* (3.66)	3.09* (1.02)	3.66* (0.03)	0.47* (0.00)
4	12.1 (14.47)	90/10	127.75 (42.05)	41.27 (13.59)	18.20 (5.99)	6.32 (2.08)	4.81 (0.04)	0.69 (0.01)

TABLE - 1B - (continued)

PVA IN BLEND (%) VERSUS NONWOVEN PROPERTIES								
RUN #	Wt. gsy (Wt. gsm)	Rayon/ PVA %	Dry tens MD strip g/ in/gsy (g/ cm/gsm)	Wet tens MD strip g/in/gsy (g/cm/ gsm)	Dry tens CD strip g/ in/gsy (g/ cm/gsm)	Wet tens CD strip g/ in/gsy (g/ cm/gsm)	H-O-M Soft MD strip gmf/ gsy (N/ gsm)	H-O-M Soft CD strip gmf/ gsy (N/ gsm)
5	12.2 (14.59)	84/16	126.31 (41.58)	37.11 (12.22)	19.94 (6.56)	6.03 (1.98)	4.86 (0.04)	0.73 (0.01)
6	14.2 (16.98)	82/18	136.61 (44.97)	39.97 (13.16)	15.77 (5.19)	6.03 (1.98)	5.45 (0.04)	1.00 (0.01)

[0032] To determine the optimal fiber compositional ranges, tests were conducted using different blends of PVA binding fibers and rayon fibers. For these tests, the product to be optimized was for use as a tampon overwrap. All trials were run at 50 fpm (0.25 m/s) using scrambled web. The same fabrication process as in Example 1 was used, except that no pre-wet flooder or vacuum removal of excess water was used. Instead the web was fed through a padder which controlled the amount of water added to the web.

[0033] Table IB shows a summary of the PVA fiber composition of the sample fabrics and their measured physical properties. Figs. 5-10 are bar charts depicting the tests results comparatively for different measured properties. Fig. 5 illustrates the PVA fiber percentage amount versus weight-normalized MD dry tensile strength, Fig. 6 the PVA fiber percentage versus MD wet tensile strength, Fig. 7 the PVA fiber percentage versus CD dry tensile strength, Fig. 8 the PVA fiber percentage versus CD wet tensile strength, Fig. 9 the PVA fiber percentage versus MD dry softness (handle-o-meter) values, and Fig. 10 the PVA fiber percentage versus CD dry softness values.

[0034] The above test results showed that the measured properties were excellent for PVA fiber percentages of 10% or less. The graphs in Figs. 5-10 confirm that there is no additional value in increasing the PVA fiber percentage greater than 10% as the properties showed no statistically significant improvement. Thus, the boundary for optimal PVA fiber composition was established at 10%. In particular, the overall combination of wet and dry tensile strength and softness (values designated with asterisks) was better for PVA fiber percentages of 2%, 4%, and 8% as compared to percentages of 10% and higher. Optimum properties (adequate strength and softness) for a tampon overwrap were obtained at the 8% PVA fiber level.

[0035] Figs. 11 and 12 illustrate the interaction of the two most important variables to optimize, i.e., wet strength and dry softness. For this comparison, the values were normalized on a fabric weight basis to eliminate the effects of weight variations. The PVA fiber percentages are shown along the X-axis. Weight-normalized wet tensile strength values (g/in/gsy) (g/cm/gsm) are shown along the Y1-axis. The higher the value, the stronger is the material. The inverse of weight-normalized handle-o-meter values (gsy/gmf) (gsm/N) are shown along the Y2-axis. The higher the value, the softer is the material. These charts confirm that the optimal combination of wet strength and softness is obtained at about 8% PVA fiber composition.

Example 2: 92/8% Rayon/PVA Blend

[0036] Further tests were conducted for the optimal rayon/PVA fiber blend, using 92% rayon (1.5 dpf x 40 mm (1.67 dtext/filament), Courtaulds Rayon 18453) with 8% PVA fibers (3.0 dpf x 51 mm (3.33 dtext/filament), Kuraray PVA VPB 201 X 51). Two card units were used. Two sample runs were obtained using hot water at 60°C for the padder with and without a lubricity agent obtained from Findley Company, of Wauwatosa, Wisconsin, U.S.A., under the designation L9120. The padder used a doctor blade pressure of 40 psi (2.8×10^5 Pa), nip pressure of 40 psi (2.8×10^5 Pa), and roll type of 30 cc/yd^2 (35.9 cc/m^2). The line speed was 50 feet/minute. The steam pressure was 20 psi (1.4×10^5 Pa) around the first-stage heating cylinders and 40 psi (2.8×10^5 Pa) around the second-stage heating cylinders. The fabric had a basis weight of 12 to 15 g/yd^2 (14.4 to 17.9 g/m^2), width of 33 - 34 inches (83.8-86.4 cm), and a thickness of 8 - 9 mils (0.20-0.23 mm). The fabric properties are summarized in Table II.

[0037] The tests showed that the use of a lubricity agent resulted in a significant lowering of wet strength. The wet-to-dry tensile strength ratio was 33% and higher in the first run (without agent), compared to 20% and higher in the second run (with agent).

TABLE - II

RUN #	Lubricious Coatg.	DRY TENS MD STRIP gm/in (gm/cm)	WET TENS MD STRIP gm/in (gm/cm)	DRY TENS CD STRIP gm/in (gm/cm)	WET TENS CD STRIP gm/in (gm/cm)	H-O-M Soft MD STRIP gmf (N)	H-O-M Soft CD Strip gmf (N)
1	No	1679.8 (661.34)	562.9 (221.61)	181.6 (71.50)	59.0 (23.58)	31.0 (0.30400615)	7.8 (0.07649187)
2	Yes	1543.6 (607.72)	340.5 (134.06)	181.6 (71.50)	49.94 (19.66)	29.0 (0.28439285)	7.3 (0.071588545)

TABLE - III

RUN #	Weight gsy (gsm) & Caliper mils (cm)	Prodt. Hand	DRY TENS MD GRAB gm/in (gm/cm)	WET TENS MD GRAB gm/in (gm/cm)	DRY TENS CD GRAB gm/in (gm/cm)	WET TENS CDGRAB gm/in (gm/cm)	Fluid cap. gm/gm
1	88 gsy (105.25)80 mil (0.2032)	Flexbl	3405.0 (1340.55)	1589.0 (625.59)	998.8 (393.23)	544.8 (214.49)	18.2
2	94 gsy (112.42)72 mil (0.18288)	Flexbl	4040.6 (1590.79)	1725.2 (679.21)	3178.0 (1251.18)	1407.4 (554.09)	17.6
3	96 gsy (114.82)63 mil (0.16002)	Stiff	9216.2 (3628.43)	3450.4 (1358.4)	2360.8 (929.45)	1044.2 (411.10)	15.0

Example 3: Hydroentangled Cotton/PVA Blend

[0038] As a process variation, tests were also conducted for hydroentangled nonwoven fabric. The nonwoven web was passed through a patterning/aperturing station for low-energy hydroentanglement on a patterned/apertured support surface to enhance the fabric's strength and texture. The fiber blend used was 92% cotton staple fibers and 8% PVA fibers (3.0 dpf (3.33 dtex/filament) x 51 mm). Two card units with scramblers for randomized fiber orientation were used. Three sample runs were obtained at different basis weights between 88 - 96 g/yd^2 (105 to 115 g/m^2) with and without the doctor blade at the padder. The padder used nip pressure of 40 psi (2.8x10^5 Pa), roll type of 30 cc/yd^2 (35.9 cc/m^2), and cold water mix. The line speed was 50 feet/minute (0.25 m/s). The steam pressure was 20 psi (1.4x10Pa) around the first-stage heating cylinders and 40 psi (2.8x10^5 Pa) around the second-stage heating cylinders. Fluid absorptive capacity was measured in grams of water absorbed per gram of fabric. Strength was measured with a grab test (4" x 6" sample) (10.2 cm x 15.2 cm sample). The results are summarized in Table III.

[0039] The results showed an increase in CD wet strength using low-energy hydroentanglement (compared to Example 2 above). Wet strength was increased when the fabric was made stiffer. Fluid absorptive capacity was comparable in all runs. Other fluid handling parameters were also measured. The fabric samples showed sink times of 1.6 to 1.8 seconds, wicking in the MD of 3.0 to 3.3 cm/sec, and wicking in the CD of 3.0 to 3.3 cm/sec. The wet-to-dry strength ratio ranged between 33% to 50%.

Example 4: Chembond Type Rayon/PVA Blend

[0040] The fiber blend used was 92% rayon (1.5 dpf (1.67 dtex/filament) x 40 mm) and 8% PVA fibers (3.0 dpf (3.33 dtex/filament) x 51 mm) . Five sample runs were obtained at different basis weights between 37 - 75 g/yd^2 (44.3-89.7 g/m^2). The tests sought to maximize MD stiffness. Two or three card units (depending on weight) with scramblers, hot water of 100°C in the flooder, variable padder nip pressure, and variable vacuum pressure were used. The line speed was 50 feet/minute (0.25 m/s). The steam pressure was 20 psi (1.4x10^5 Pa) around the first-stage cylinders and 40

psi ($2.8x10^5$ Pa) around the second-stage cylinders. Fluid absorbent capacity and drape softness/stiffness were also measured. The measured properties are summarized in Table IV.

[0041] The test showed that using limited quantities of PVA fiber in the blend and making a "chembond" type fabric allows the manufacture of a product with good strengths and absorption capacity, with enough flexibility to vary the weight, thickness, softness, etc., as desired for different grades of product.

[0042] Referring to Fig. 2, a variation of the fabrication process line is shown for handling nonwoven fabric of greater weight and absorbent capacity such as used for baby wipes. The PVA and other fibers are blended completely in a homogenized manner and supplied to (three) card units 21 at a carding station 20 with or without the use of scramblers. The carded fibers are transported on a card conveyor 22. The carded web is passed through a pre-wet station 23 which is essentially a flooder wherein hot or cold water from a tank is applied onto the web controlled using a valve.

[0043] The web is passed through an aperturing station 25 using a low energy hydroentangling module. This consists of a perforated rotary drum wherein water jets from manifolds 26, 27, 28 impinge the web at pressure ranging from 50 - 400 psi ($3.4x10^5$ Pa to $2.8x10^6$ Pa). The action of the water jets on the web not only imparts strength through fiber entanglement but also a pattern depending on the pattern of perforations in the aperturing surface. This stage enhances the final fabric's strength and feel/textural aesthetics. A post-aperturing vacuum module 29 is used to suck off excess water from the apertured web, which is important to controlling the hand of the final fabric.

TABLE - IV

RUN #	Wt., gsy (gsm) and Calper mils (cm)	Prod. Hand	DRY TENS MD GRAB gm/in (gm/cm)	DRY TENS CD GRAB gm/in (gm/cm)	Drape Stiffness MD STRIP gmf (N)	Drape Stiffness CD STRIP gmf (N)	Fluid cap. gm/gm
1	37 gsy (44.25) 18 mils (0.05)	Very Stiff	9080.0 (3574.80)	3951.0 (1555.51)	18.5 (0.18)	11.4 (0.11)	12.6
2	37 gsy (44.25) 16 mils (0.04)	Very Stiff	11123.0 (4379.13)	2814.8 (1108.19)	18.4 (0.18)	10.6 (0.10)	12.6
3	50 gsy (59.80) 22 mils (0.06)	Very Stiff	12848.2 (5058.35)	4313.0 (1698.03)	18.5 (0.18)	12.5 (0.12)	12.3
4	75 gsy (89.70) 34 mils (0.09)	Stiff, Bulky & Softer	12666.6 (4986.85)	2406.2 (947.32)	14.7 (0.14)	9.4 (0.09)	14.1
5	67 gsy (80.13) 34 mils (0.09)	Stiff, Bulky & Softer	9488.6 (3735.67)	2678.6 (1054.57)	17.0 (0.17)	8.3 (0.08)	14.3
6	78 gsy (93.29) 35 mils (0.09)	Stiff, Bulky & Softer	12258.0 (4825.98	2814.8 (1108.19)	17.1 (0.17)	8.3 (0.08)	13.0

[0044] With the desired amount of water present in the web and just enough web integrity, the web is passed through a padder station 30 where water is applied to the web in a controlled amount under a nip roll. The web is then passed through two stages of hot cylinders 31 and 32 for bonding of the fibers and drying. The bonded fabric is wound up at a winding station 33. Examples of apertured rayon/PVA fabric produced in this process line are given below.

Example 5: Hydroentangled Rayon/PVA Blend

[0045] A first test for apertured nonwoven fabric used a fixed fiber blend of 96% rayon (1.5 dpf (1.67 dtex/filament) x 40 mm) and 4% PVA fibers (3.0 dpf (3.33 dtex/filament) by 51 mm). A cold water pre-wet flooder was not used. The manifold pressures at the aperturing station were all 150 psi ($1.0x10^6$ Pa). The postaperturing vacuum pressure was -70.0 to -80.0 psi ($-4.8x10^5$ to $-5.5x10^5$ Pa). The doctor blade and nip roller of the padder were not used. The line speed was 50 fpm (0.25 m/s). The steam pressure was 30 psi ($2.1x10^5$ Pa) around the first-stage cylinders and 40 psi ($2.8x10^5$ Pa) around the second-stage cylinders. Five samples were tested, with Runs #4 and #5 having a top layer of 5 dpf

(5.56 dtex/filament) rayon. Drape was measured using the INDA Standard Test for Stiffness (IST 90.1 - 92) in centimeters of bend (the higher the value, the stiffer the fabric). The measured fabric properties are summarized in Table VA.

[0046] The test results in Table VA showed wet-to-dry strength ratios ranging between 25% to 40%, relatively soft hand, and good absorptive capacity. Sink times of 2.4 to 3.0 seconds, wicking in the MD of 4.0 to 6.0 cm/sec, and wicking in the CD of 3.7 to 4.9 cm/sec were also measured.

[0047] Tests of different rayon/PVA fiber blends were then conducted to determine the optimal fiber compositional ranges, where the product was optimized to be used as a baby wipe. All trials were run at 50 fpm (0.25 m/s) using scrambled web. The same fabrication process for apertured fabric as in the tests for Table VA was used.

TABLE - VA

Run #	Wgt/Thick	Dry Strip TS	Wet Strip TS	Drape (cms)	Fluid Capacity
1.	51 gsy (60.9954894433551634 gsm) 28 mils (0.07112 cm)	MD 2637 g CD 250 g	MD 924 g CD 166 g	MD 13.4 CD 5.0	15.0 g/g
2.	45 gsy (53.8195495088427912 gsm) 283 mils (0.05842 cm)	MD 3634 g CD 288 g	MD 1198 g CD 134 g	MD 15.8 CD 4.9	14.0 g/g
3.	68 gsy (81.3273192578068845 gsm) 32 mils (0.08128 cm)	MD 6854 g CD 582 g	MD 2101 g CD 244 g	MD 18.5 CD 75.0	13.5 g/g
4.	61 gsy (72.9553893342091169 gsm) 35 mils (0.0889 cm)	MD 4192 g CD 441 g	MD 1494 g CD 167 g	MD 15.4 CD 6.0	14.1 g/g
5.	52 gsy (62.1914794324405587 gsm) 29 mils (0.07366)	MD 4270 g CD 266 g	MD 1187 g CD 141 g	MD 16.2 CD 4.7	14.4 g/g

TABLE - VB

- PVA IN BLEND (%) VERSUS NONWOVEN PROPERTIES						
RUN #	Wt.gsy (gsm)	Rayon/ PVA %	Dry tens MD strip g/in/gsy (g/cm/gsm)	Wet tens MD strip g/in/gsy (g/cm/gsm)	Dry tens CD strip g/in/gsy (g/cm/gsm)	Wet tens CD strip g/in/gsy (g/cm/gsm)
1	64.5 (77.14)	98/2	65.2° (21.46)	27.3 (8.99)	4.3° (1.42)	N/A (N/A)
2	36.4 (75.83)	96/4	66.8° (21.99)	27.9° (9.18)	5.5° (1.81)	4.3° (1.42)
3	71.1 (85.03)	90/10	98.7 (32.49)	33.1 (10.90)	13.1 (4.31)	5.5 (1.81)
4	72.8 (87.07)	84/16	110.3 (36.31)	33.1 (10.90)	16.2 (5.33)	5.0 (1.65)
5	69.5 (83.12)	82/18	127.2 (41.87)	38.4 (12.64)	15.4 (5.07)	5.9 (1.94)

[0048] Table VB shows a summary of the PVA fiber compositions and their nonwoven properties. Figs. 13-16 are bar charts depicting the tests results comparatively. Fig. 13 illustrates the PVA fiber percentage amount versus weight-normalized MD dry tensile strength, Fig. 14 the PVA fiber percentage versus CD dry tensile strength, Fig. 15 the PVA fiber percentage versus MD wet tensile strength, and Fig. 16 the PVA fiber percentage versus CD wet tensile strength.

[0049] The test results showed that the values for the lower PVA fiber percentages, i.e., 2% and 4%, were statistically better than the values obtained for the 10%, 16%, and 18% rayon/PVA blends. There was little additional value in increasing the PVA fiber composition greater than 10% as the resulting properties showed no significant improvement.

[0050] Fig. 17 illustrates the interaction of the two important variables to be optimized, i.e., cross directional wet strength and cross directional softness (inverse of dry stiffness). Both values were normalized on a fabric weight basis to eliminate the effects of weight variations. The PVA fiber percentages are shown along the X-axis. Weight-normalized wet tensile strength values (g/in/gsy (g/cm/gsm)) are shown along the Y1-axis. The higher the value, the stronger is the material. The inverse of weight-normalized drape stiffness (gsy/gmf(gsm/N)) are shown along the Y2-axis. The higher the value, the softer is the material. The value lines intersect at 8% PVA fiber blend, representing an optimal combination of wet strength and softness.

Example 6: Hydroentangled Rayon/PVA Blend

[0051] The fiber blend used was 96% rayon (1.5 dpf (1.67 dtex/filament) x 40 mm) and 4% PVA fibers (3.0 dpf (3.33 dtex/filament) by 51 mm). A cold water pre-wet flooder was used. The manifold pressures at the aperturing station

were 150 and 200 psi($1.0x10^6$ Pa and $1.46x10^6$ Pa). The post-aperturing vacuum pressure was -40.0 psi ($-2.8x10^5$ Pa). The doctor blade and nip roller of the padder were not used. The line speed was 50 fpm (0.25 m/s). The steam pressure was 20 psi (1.4x10 Pa)around the first-stage cylinders and 40 psi ($2.8x10^5$ Pa) around the second-stage cylinders.

[0052] Different weights and thicknesses of fabric were tested, and the measurements for the resulting properties are summarized in Table VI. The test results showed wet-to-dry strength ratios ranging between 20% to 50%, good softness values, and high fluid absorption capacities.

[0053] In summary, nonwoven fabrics having low amounts of PVA fibers bonded to other absorbent fibers such as rayon and cotton are found to have sufficient wet strength and good hand and softness along with excellent fluid handling and absorption properties. These nonwoven fabrics are highly suitable for use in tampons, diapers, sanitary napkins, wipes, and medical products. The fluid holding capacity can be increased when superabsorbent fibers are introduced in the matrix and bonded together with the PVA fibers. Hence, these fabrics also find ideal use as an absorptive core material.

[0054] The proportion of PVA fibers in the matrix can be varied depending on the denier and staple length employed. PVA fiber blends of from about 2% up to about 10% are found to provide the required wet strength and softness properties desired for the applications mentioned above. These low amounts provide a wet-to-dry tensile strength ratio of at least 25% in the machine direction (MD) and in the cross direction (CD), drape softness of between 0.5 to 4.0 gmf/gsy ($4.1x10^{-3}$ to $3.3x10^{-2}$ N/gsm) in the MD and 0.1 to 0.5 gmf/gsy ($8.2x10^{-4}$ to $4.1x10^{-3}$ N/gsm) in the CD. Apertured nonwoven fabric having the PVA binding have high fluid absorptive capacities of between 8 and 20 grams of water per gram of fabric. More than 10% of PVA fibers does not provide an appreciable increase in strength but has increased stiffness, which is a deterrent to use in many of the applications mentioned. Softness and wet strength are the principal combination of properties desired.

TABLE - VI

PROPERTIES	ROLL # 1	ROLL # 2	ROLL # 3
WEIGHT/THICKNESS			
Weight, gsy (gsm)	67.7 (80.79)	65.3 (78.10)	69.6 (83.24)
Thickness, mils (cm)	33.0 (0.08)	31.0 (0.08)	33.1 (0.08)
DRY-STRIP			
MD Tensile, g	5436.0	4617.0	6541.0
CD Tensile, g	539.1	408.5	628.0
MD Elongation, %	9.8	10.5	9.3
CD Elongation, %	41.0	38.8	30.8
WET-STRIP (H20)			
MD Tensile, g	1577.0	1588.0	2053.0
CD Tensile, g	227.4	178.5	259.0
MD Elongation, %	24.4	26.7	23.0
CD Elongation, %	115.5	89.3	103.6
DRY GRAB TENSILE			
MD Tensile, g	8762.2	7536.4	10396.6
CD Tensile, g	2270.0	1816.0	2996.4
MD Elongation, %	12.0	12.6	10.5
CD Elongation, %	53.0	53.0	49.3
WET-GRAB (H2O)			
MD Tensile, g	3132.6	2905.6	3541.2
CD Tensile, g	1089.6	1225.8	1316.6
MD Elongation, %	34.9	36.1	32.4
CD Elongation, %	170.5	182.6	162.2
DRY-STRIP TOUGH.			
MD Tough., g/in2 (g/cm2)	451.5 (69.98)	395.3 (61.27)	488.0 (75.64)
CD Tough., g/in2 (g/cm2)	190.6 (29.54)	144.5 (22.40)	170.0 (26.37)
WET-STRIP (H2O)			
MD Tough., g/in2 (g/cm2)	337.0 (52.24)	377.7 (58.54)	397.6 (61.63)
CD Tough., g/in2 (g/cm2)	163.5 (25.34)	116.5 (18.06)	178.2 (27.62)
DRY-GRAB TOUGH.			
MD Tough., g/in2 (g/cm2)	280.2 (43.43)	311.6 (48.30)	368.2 (57.07)
CD Tough., g/in2 (g/cm2)	312.0 (48.36)	235.0 (36.43)	373.5 (57.89)
WET-GRAB (H20)			
MD Tough., g/in2 (g/cm2)	397.0 (61.54)	361.0 (55.96)	379.6 (58.84)
CD Tough., g/in2 (g/cm2)	337.0 (52.24)	371.3 (57.55)	381.2 (59.09)
STIFFNESS			
MD Drape, cms	16.9	15.2	18.5
CD Drape, cms	6.8	5.1	7.6
ABSORPTION			
Sink time, secs	1.44	1.43	1.78
Capacity, g/g	13.0	12.6	12.0

TABLE - VI (cont'd)

PROPERTIES	ROLL # 4	ROLL # 5	ROLL # 6
WEIGHT/THICKNESS			
Weight, gsy (gsm)	69.0 (82.52)	63.8 (76.30)	64.4 (77.02)
Thickness, mils (cm)	33.0 (0.08)	32.8	31.1 (0.08)
DRY-STRIP			
MD Tensile, g	6212.0	4173.0	4504.4
CD Tensile, g	729.4	452.8	125.4
MD Elongation, %	9.7	10.4	9.6
CD Elongation, %	38.0	41.5	41.6
WET-STRIP (H20)			
MD Tensile, g	2150.0	1452.0	1390.0
CD Tensile, g	259.3	254.0	81.2
MD Elongation, %	24.1	26.2	25.7
CD Elongation, %	95.7	115.3	116.7
DRY GRAB TENSILE			
MD Tensile, g	9761.0	7854.2	7536.4
CD Tensile, g	2542.4	1997.6	1634.4
MD Elongation, %	10.8	12.6	12.5
CD Elongation, %	49.7	63.1	78.5
WET-GRAB (H2O)			
MD Tensile, g	3541.2	2769.4	2724.0
CD Tensile, g	1180.4	1316.6	1135.0
MD Elongation, %	32.8	42.1	40.2
CD Elongation, %	154.0	200.0	194.2
DRY-STRIP TOUGH.			
MD Tough., g/in2 (g/cm2)	473.6 (73.41)	347.6 (53.88)	384.5 (59.60)
CD Tough., g/in2 (g/cm2)	215.1 (33.34)	176.4 (27.34)	45.8 (7.10)
WET-STRIP (H2O)			
MD Tough., g/in2 (g/cm2)	425.4 (65.94)	332.0 (51.46)	367.7 (56.99)
CD Tough., g/in2 (g/cm2)	166.7 (25.84)	179.7 (27.85)	57.8 (8.96)
DRY-GRAB TOUGH.			
MD Tough., g/in2 (g/cm2)	311.6 (48.30)	274.0 (42.47)	307.5 (47.66)
CD Tough., g/in2 (g/cm2)	331.8 (51.43)	309.0 (47.90)	302.0 (46.81)
WET-GRAB (H20)			
MD Tough., g/in2 (g/cm2)	425.4 (65.94)	333.7 (51.72)	373.4 (57.88)
CD Tough., g/in2 (g/cm2)	166.7 (25.84)	446.4 (69.19)	361.2 (55.99)
STIFFNESS			
MD Drape, cms	18.5	13.7	15.2
CD Drape, cms	8.9	5.9	6.5
ABSORPTION			
Sink time, secs	1.7	1.66	1.62
Capacity, g/g	12.2	12.8	12.7

TABLE - VI (cont'd)

PROPERTIES	ROLL # 7	ROLL # 8	ROLL # 9
WEIGHT/THICKNESS			
Weight, gsy (gsm)	59.7 (71.40)	62.5 (74.75)	64.0 (76.54)
Thickness, mils (cm)	29.2 (0.07)	30.0 (0.08)	30.5 (0.08)
DRY-STRIP			
MD Tensile, g	4012.0	4327.0	4512.0
CD Tensile, g	396.2	382.9	148.1
MD Elongation, %	11.2	11.1	9.2
CD Elongation, %	48.7	38.4	35.6
WET-STRIP (H20)			
MD Tensile, g	1564.0	1409.0	1638.0
CD Tensile, g	203.0	238.1	231.6
MD Elongation, %	26.8	26.7	24.6
CD Elongation, %	107.4	110.5	118.0
DRY GRAB TENSILE			
MD Tensile, g	7491.0	7536.4	7808.8
CD Tensile, g	1816.0	1725.2	1997.6
MD Elongation, %	13.0	12.6	12.6
CD Elongation, %	77.5	63.6	74.8
WET-GRAB (H2O)			
MD Tensile, g	2814.8	2724.0	2678.6
CD Tensile, g	1362.0	1271.2	1225.8
MD Elongation, %	39.6	37.1	35.6
CD Elongation, %	199.3	194.6	184.7
DRY-STRIP TOUGH.			
MD Tough., g/in2 (g/cm2)	372.0 (57.66)	391.2 (60.64)	340.3 (52.75)
CD Tough., g/in2 (g/cm2)	164.4 (25.48)	124.1 (19.24)	45.6 (7.07)
WET-STRIP (H2O)			
MD Tough., g/in2 (g/cm2)	367.6 (56.98)	353.3 (54.76)	366.3 (56.78)
CD Tough., g/in2 (g/cm2)	135.1 (20.94)	161.2 (24.99)	165.0 (25.58)
DRY-GRAB TOUGH.			
MD Tough., g/in2 (g/cm2)	272.4 (42.22)	281.1 (43.57)	269.5 (41.77)
CD Tough., g/in2 (g/cm2)	316.8 (49.10)	279.3 (43.29)	358.2 (55.52)
WET-GRAB (H20)			
MD Tough., g/in2 (g/cm2)	414.6 (64.26)	356.0 (55.18)	334.8 (51.89)
CD Tough., g/in2 (g/cm2)	428.4 (66.40)	420.4 (65.16)	382.4 (59.27)
STIFFNESS			
MD Drape, cms	15.0	15.9	16.5
CD Drape, cms	6.5	6.8	5.5
ABSORPTION			
Sink time, secs	1.7	1.54	1.63
Capacity, g/g	12.5	12.0	12.5

TABLE - VI (cont'd)

PROPERTIES	ROLL # 10	ROLL # 11	ROLL # 12
WEIGHT/THICKNESS			
Weight, gsy (gsm)	68.4 (81.81)	64.5 (77.14)	70.5 (84.32)
Thickness, mils (cm)	34.2 (0.09)	31.7 (0.08)	34.8 (0.09)
DRY-STRIP			
MD Tensile, g	5048.0	5193.0	6112.0
CD Tensile, g	173.4	221.8	268.1
MD Elongation, %	9.7	8.7	9.2
CD Elongation, %	36.6	40.3	34.4
WET-STRIP (H20)			
MD Tensile, g	1433.0	1746.0	2154.0
CD Tensile, g	244.7	118.5	298.7
MD Elongation, %	26.6	24.8	23.8
CD Elongation, %	115.0	121.3	115.1
DRY GRAB TENSILE			
MD Tensile, g	8081.2	9307.0	10896.0
CD Tensile, g	1997.6	2542.4	2860.2
MD Elongation, %	12.4	12.0	12.3
CD Elongation, %	63.8	55.5	51.1
WET-GRAB (H2O)			
MD Tensile, g	3041.8	3087.2	3405.0
CD Tensile, g	1089.5	1362.0	1362.0
MD Elongation, %	39.9	33.3	30.0
CD Elongation, %	166.2	185.0	169.7
DRY-STRIP TOUGH.			
MD Tough., g/in2 (g/cm2)	377.5 (58.51)	384.5 (59.60)	442.1 (68.53)
CD Tough., g/in2 (g/cm2)	56.8 (8.80)	72.6 (11.25)	79.0 (12.25)
WET-STRIP (H2O)			
MD Tough., g/in2 (g/cm2)	359.6 (55.74)	402.0 (62.31)	439.6 (68.14)
CD Tough., g/in2 (g/cm2)	178.0 (27.59)	86.2 (13.36)	216.4 (33.54)
DRY-GRAB TOUGH.			
MD Tough., g/in2 (g/cm2)	333.9 (51.75)	331.3 (51.35)	397.7 (61.64)
CD Tough., g/in2 (g/cm2)	310.7 (48.16)	381.5 (59.13)	368.4 (57.10)
WET-GRAB (H20)			
MD Tough., g/in2 (g/cm2)	376.6 (58.37)	348.4 (54.00)	464.9 (72.06)
CD Tough., g/in2 (g/cm2)	356.5 (55.26)	400.1 (62.02)	434.9 (67.41)
STIFFNESS			
MD Drape, cms	18.3	18.4	18.6
CD Drape, cms	7.3	6.7	7.8
ABSORPTION			
Sink time, secs	1.77	1.62	1.63
Capacity, g/g	12.6	12.2	12.3

[0055] Although the above examples use cotton and rayon matrix fibers, the PVA binding fibers can also be used with synthetic fibers such as acetate, polyester, polypropylene, polyethylene, nylon, etc. They may also be used with other types of fibers to form higher strength and/or denser nonwoven fabrics such as spunbond, spunlaced, and thermally bonded nonwovens, in order to obtain superior hydrophilic and oleophilic wipes.

Claims

1. Nonwoven fabric comprising from about 2% up to about 10% of untreated, water-soluble polyvinyl alcohol (PVA) fibres that are heat-bonded to a matrix of absorbent fibres such that said fabric has a wet-to-dry tensile strength ratio of at least 25% in the machine direction (MD) and cross direction (CD) and a drape softness of from 0.5 to 4.0 gmf/gsy ($1.4x10^{-3}$ to $3.3x10^{-2}$ N/gsm) in the MD and 0.1 to 0.5 gmf/gsy ($8.2x10^{-4}$ to $4.1x10^{-3}$ N/gsm) in the CD.

2. A nonwoven fabric according to Claim 1, wherein the preferred range of PVA fibres is from about 4% to about 8% per dry weight of fabric.

3. A nonwoven fabric according to Claim 1 or Claim 2, wherein the absorbent fibres are cellulosic fibres.

4. A nonwoven fabric according to Claim 1 or Claim 2, having a preferred composition of about 8% by weight of PVA fibres and 92% by weight of rayon as the absorbent fibres.

5. A nonwoven fabric according to Claim 1 or Claim 2, having a preferred composition of about 8% by weight of PVA fibres and 92% by weight of cotton as the absorbent fibres.

6. A nonwoven fabric according to Claim 1 or Claim 2, wherein the absorbent fibres are synthetic fibres selected from the group comprising acetate, polyester, polypropylene, polyethylene, and nylon.

7. A nonwoven fabric according to any one of Claims 1 to 6, wherein the fiber blend is formed as an apertured fabric.

8. A nonwoven fabric according to any one of claims 1 to 7, having a fluid absorptive capacity of between 8 and 20 grams of water per gram of fabric.

9. A method for producing a nonwoven fabric comprising the steps of:

   blending untreated, water-soluble PVA fibres with a matrix of absorbent fibres;
   carding the blended fibres onto a moving web;
   adding water to the web in an amount sufficient to soften the PVA fibres for binding to the absorbent fibres while maintaining sufficient web integrity;
   heating the wetted web in a first stage of heating cylinders in a temperature range of about 40°C to 80°C to bind the PVA fibres to the other absorbent fibres;
   then further heating the web in a second stage of heating cylinders in a temperature range of about 60°C to 100°C to complete the binding of the fibres and drying of the web.

10. A method for producing a nonwoven fabric according to Claim 9, wherein wetting of the web is obtained by adding water through a water pickup station then removing excess water from the wetted web through vacuum suctioning.

11. A method for producing a nonwoven fabric according to Claim 9, wherein wetting of the web is obtained by adding controlled amounts of water through a padder.

12. A method for producing a nonwoven fabric according to any one of claims 9 to 11, further comprising the step of passing the web through an aperturing station for low-energy hydroentanglement of the fibres prior to wetting the web and two-stage heating.

13. A method for producing a nonwoven fabric according to any one of Claims 9 to 12, wherein the PVA fibres comprise from about 2% to about 10% per dry weight of fabric.

14. A method for producing a nonwoven fabric according to any one of Claims 9 to 13, wherein the absorbent fibres are cellulosic fibres.

15. A method for producing a nonwoven fabric according to any one of Claims 9 to 13, wherein a preferred fiber composition has about 8% by weight of PVA fibres and 92% by weight of rayon as the absorbent fibres.

16. A method for producing a nonwoven fabric according to any one of Claims 9 to 13, wherein a preferred fiber composition has about 8% by weight of PVA fibres and 92% by weight of cotton as the absorbent fibres.

17. A method for producing a nonwoven fabric according to any one of Claims 9 to 13, wherein the absorbent fibres are synthetic fibres selected from the group comprising acetate, polyester, polypropylene, polyethylene, and nylon.

18. A nonwoven fabric produced by the method according to Claim 9 wherein the PVA fibres comprise from about 2% to about 10% per dry weight of fabric.

19. A nonwoven fabric produced by the method according to Claim 9 comprising about 8% by weight of PVA fibres and 92% by weight of rayon fibres.

Patentansprüche

1. Nicht-gewebter Stoff mit etwa 2 % bis 10 % unbehandelten, wasserlöslichen Polyvinylalkohol-(PVA)-Fasern, welche durch Wärme mit einer Matrix von saugfähigen Fasern in der Weise verbunden sind, daß dieser Stoff ein Naß-Trocken-Zugfestigkeitsverhältnis von mindestens 25 % in der Bearbeitungsrichtung (MD) und in der Querrichtung (CD) sowie eine Faltungsweichheit von 0,5 bis 4,0 gmf/gsy (1,4 x 10^{-3} bis 3,3 x 10^{-2} N/gsm) in der Bearbeitungsrichtung (MD) und 0,1 bis 0,5 gmf/gsy (8,2 x 10^{-4} bis 4,1 x 10^{-3} N/gsm) in der Querrichtung (CD) aufweist.

2. Nicht-gewebter Stoff nach Anspruch 1, bei welchem der bevorzugte Anteil von PVA-Fasern etwa 4 % bis etwa 8 % des Trockengewichtes des Stoffes beträgt.

3. Nicht-gewebter Stoff nach Anspruch 1 oder 2, bei welchem die saugfähigen Fasern Zellulosefasern sind.

4. Nicht-gewebter Stoff nach Anspruch 1 oder 2, welcher eine bevorzugte Zusammensetzung von etwa 8 Gewichts-% PVA-Fasern und 92 Gewichts-% Rayon als sangfähige Fasern aufweist.

5. Nicht-gewebter Stoff nach Anspruch 1 oder 2, welcher eine bevorzugte Zusammensetzung von etwa 8 Gewichts-% PVA-Fasern und 92 Gewichts-% Baumwolle als saugfähige Fasern aufweist.

6. Nicht-gewebter Stoff nach Anspruch 1 oder 2, bei welchem die saugfähigen Fasern synthetische Fasern sind, welche aus der Gruppe, welche Azetat, Polyester, Polypropylen, Polyethylen und Nylon umfaßt, ausgewählt sind.

7. Nicht-gewebter Stoff nach einem der Ansprüche 1 bis 6, bei welchem die Fasermischung als ein löchriger Stoff ausgebildet ist.

8. Nicht-gewebter Stoff nach einem der Ansprüche 1 bis 7, welcher ein Flüssigkeitsabsorptionsvermögen von zwischen 8 und 20 Gramm Wasser pro Gramm des Stoffes besitzt.

9. Verfahren zur Herstellung eines nicht-gewebten Stoffes mit folgenden Schritten:

   Vermischung von unbehandelten, wasserlöslichen PVA-Fasern mit einer Matrix von saugfähigen Fasern;
   Kardieren der gemischten Fasern auf ein bewegtes Netz;
   Zugabe von Wasser auf das Netz in einer Menge, die geeignet ist, um die PVA-Fasern zu erweichen, um sie mit den saugfähigen Fasern zu verbinden, wobei eine ausreichende Integrität des Netzes aufrechterhalten wird;
   Erwärmen des benäßten Netzes in einem ersten Abschnitt von Heizzylindern auf einen Temperaturbereich von etwa 40 °C bis 80 °C, um die PVA-Fasern mit den anderen saugfähigen Fasern zu verbinden;
   und dann ein weiteres Erwärmen des Netzes in einem zweiten Abschnitt von Heizzylindern auf einen Temperaturbereich von etwa 60 °C bis 100 °C, um die Verbindung der Fasern zu vollenden und das Netz zu trocknen.

10. Verfahren zur Herstellung eines nicht-gewebten Stoffes nach Anspruch 9, bei welchem das Benässen des Netzes durch Zugabe von Wasser mittels einer Wasseraufnahmestation erreicht wird, welche dann das überschüssige

Wasser vom benäßten Netz durch Vakuumsaugen entfernt.

11. Verfahren zur Herstellung eines nicht-gewebten Stoffes nach Anspruch 9, bei welchem das Benässen des Netzes durch Zuführung gesteuerter Wassermengen mittels eines Polsterkissens erfolgt.

12. Verfahren zur Herstellung eines nicht-gewebten Stoffes nach einem der Ansprüche 9 bis 11, welches weiterhin den Schritt des Durchlaufens des Netzes durch eine Auflockerungsstation enthält, um eine nieder energetusche Hydroverflechtung der Fasern vor dem Benässen des Netzes und der zweistufigen Erwärmung durchzuführen.

13. Verfahren zur Herstellung eines nicht-gewebten Stoffes nach einem der Ansprüche 9 bis 12, bei welchem die PVA-Fasern etwa 2 % bis etwa 10 % des Trockengewichtes des Stoffes umfassen.

14. Verfahren zur Herstellung eines nicht-gewebten Stoffes nach einem der Ansprüche 9 bis 13, bei welchem die saugfähigen Fasern Zellulosefasern sind.

15. Verfahren zur Herstellung eines nicht-gewebten Stoffes nach einem der Ansprüche 9 bis 13, bei welchem eine bevorzugte Faserzusammensetzung etwa 8 Gewichts-% PVA-Fasern und 92 Gewichts-% Rayon als saugfähige Fasern enthält.

16. Verfahren zur Herstellung eines nicht-gewebten Stoffes nach einem der Ansprüche 9 bis 13, bei welchem eine bevorzugte Faserzusammensetzung etwa 8 Gemichts-% PVA-Fasern und 92 Gewichts-% Baumwolle als saugfähige Fasern enthält.

17. Verfahren zur Herstellung eines nicht-gewebten Stoffes nach einem der Ansprüche 9 bis 13, bei welchem die saugfähigen Fasern synthetische Fasern sind, die aus der Gruppe, welche Azetat, Polyester, Polypropylen, Polyethylen und Nylon umfaßt, ausgewählt sind.

18. Nicht-gewebter Stoff, welcher durch das Verfahren nach Anspruch 9 hergestellt ist, in welchem die PVA-Fasern etwa 2 % bis etwa 10 % des Trockengemichtes des Stoffes umfassen.

19. Nicht-gewebter Stoff, welcher durch das Verfahren nach Anspruch 9 hergestellt ist und etwa 8 Gewichts-% PVA-Fasern und 92 Gewichts-% Rayon-Fasern umfaßt.

Revendications

1. Étoffe non tissée comportant environ 2% jusqu'à environ 10% de fibres non traitées en alcool polyvinylique (PVA), solubles dans l'eau qui sont liées thermiquement à une matrice de fibres absorbantes de façon que l'étoffe présente un rapport de résistance à la traction humide-sec d'au moins 25% dans la direction de la machine (MD) et dans la direction transversale (CD) et une souplesse de drapé de 0,5 à 4,0 gml/gsy (1,4 x 10^{-3} à 3,3 x 10^{-2}N/gsm) dans la MD et de 0,1 à 0,5 gml/gsy (8,2 x 10^{-4} à 3,1 x 10^{-3} N/gsm) dans la CD.

2. Une étoffe non tissée selon la revendication 1, dans laquelle la gamme préférée de fibres en PVA est d'environ 4% à environ 8% par poids sec de l'étoffe.

3. Une étoffe non tissée selon la revendication 1 ou la revendication 2, dans laquelle les fibres absorbantes sont des fibres cellulosiques.

4. Une étoffe non tissée selon la revendication 1 ou la revendication 2, ayant une composition préférée d'environ 8% en poids de fibres en PVA et 92% en poids de rayonne en tant que fibres absorbantes.

5. Une étoffe non tissée selon la revendication 1 ou la revendication 2, ayant une composition préférée d'environ 8% en poids de fibres en PVA et 92% en poids de coton en tant que fibres absorbantes.

6. Une étoffe non tissée selon la revendication 1 ou la revendication 2, dans laquelle les fibres absorbantes sont des fibres synthétiques choisies dans le groupe comportant l'acétate, le polyester, le polypropylène, le polyéthylène et le nylon.

7. Une étoffe non tissée selon l'une quelconque des revendications 1 à 6, dans laquelle le mélange de fibres est conformé en étoffe à trous.

8. Une étoffe non tissée selon l'une quelconque des revendications 1 à 7, ayant une capacité d'absorption des fluides entre 8 et 20 grammes d'eau par gramme d'étoffe.

9. Un procédé pour fabriquer une étoffe non tissée comportant les étapes de:

   mélanger des fibres en PVA, non traitées et solubles dans l'eau, avec une matrice de fibres absorbantes ;
   garder les fibres mélangées sur une toile mobile;
   ajouter de l'eau à la toile en une quantité suffisante pour assouplir les fibres en PVA afin de les lier aux fibres absorbantes, tout en maintenant une intégrité suffisante de la toile;
   chauffer la toile mouillée dans une première étape de cylindre chauffé dans une gamme de températures d'environ 40°C à 80°C afin de lier les fibres en PVA aux autres fibres absorbantes;
   puis chauffer en outre la toile dans une seconde étape pour cylindres chauffés dans une gamme de températures d'environ 60°C à 100°C afin de terminer la liaison des fibres, suivie d'un séchage de la toile.

10. Un procédé pour préparer une étoffe non tissée selon la revendication 9, dans laquelle le mouillage de la toile est réalisée en ajoutant de l'eau par l'intermédiaire d'un poste d'amenée d'eau suivi de l'élimination de l'eau en excès à partir de la toile mouillée au moyen d'une aspiration sous vide.

11. Un procédé pour fabriquer une étoffe non tissée selon la revendication 9, dans lequel le mouillage de la toile est réalisé en ajoutant des quantités déterminées d'eau par l'intermédiaire d'un foulard.

12. Un procédé pour fabriquer une étoffe non tissée selon l'une quelconque des revendications 9 à 11, comportant en outre l'étape de faire passer la toile à travers un poste ajouré afin de réaliser un hydro-entremêlement basse-énergie des fibres avant le mouillage de la toile et le chauffage en deux étapes.

13. Un procédé pour fabriquer une étoffe non tissée selon l'une des revendications 9 à 12, dans lequel les fibres en PVA constituent d'environ 2% à environ 10% en poids sec de l'étoffe.

14. Un procédé pour fabriquer une étoffe non tissée selon l'une quelconque des revendications 9 à 13, dans lequel les fibres absorbantes sont des fibres cellulosiques.

15. Un procédé pour fabriquer une étoffe non tissée selon l'une quelconque des revendications 9 à 13, dans lequel une composition préférée des fibres possède d'environ 8% en poids de fibres en PVA et de 92% en poids de rayonne en tant que fibres absorbantes.

16. Un procédé pour fabriquer une étoffe non tissée selon l'une quelconque des revendications 9 à 13, dans lequel une composition préférée des fibres présente d'environ 8% en poids de fibres en PVA et 92% en poids de coton en tant que fibres absorbantes.

17. Un procédé pour fabriquer une étoffe non tissée selon l'une quelconque des revendications 9 à 13, les fibres absorbantes sont des fibres synthétiques choisies dans le groupe comportant l'acétate, le polyester, le polypropylène, le polyéthylène et le nylon.

18. Une étoffe non tissée fabriquée par le procédé selon la revendication 9, dans lequel les fibres en PVA constituent d'environ 2% à environ 10% par poids sec d'étoffe.

19. Une étoffe non tissée fabriquée par le procédé selon la revendication 9, comportant environ 8% en poids de fibres en PVA et 92% en poids de fibres en rayonne.

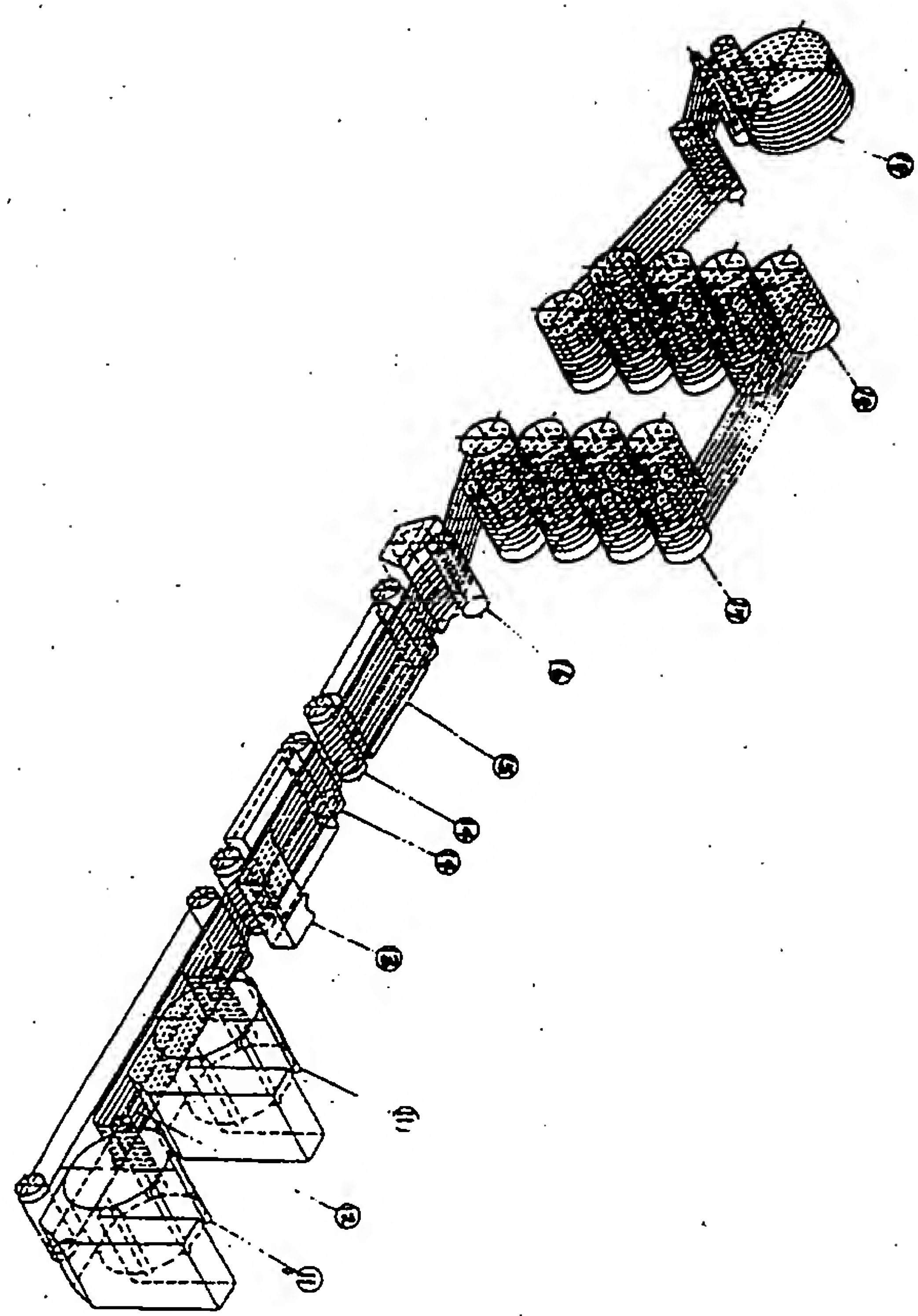


FIG. 1

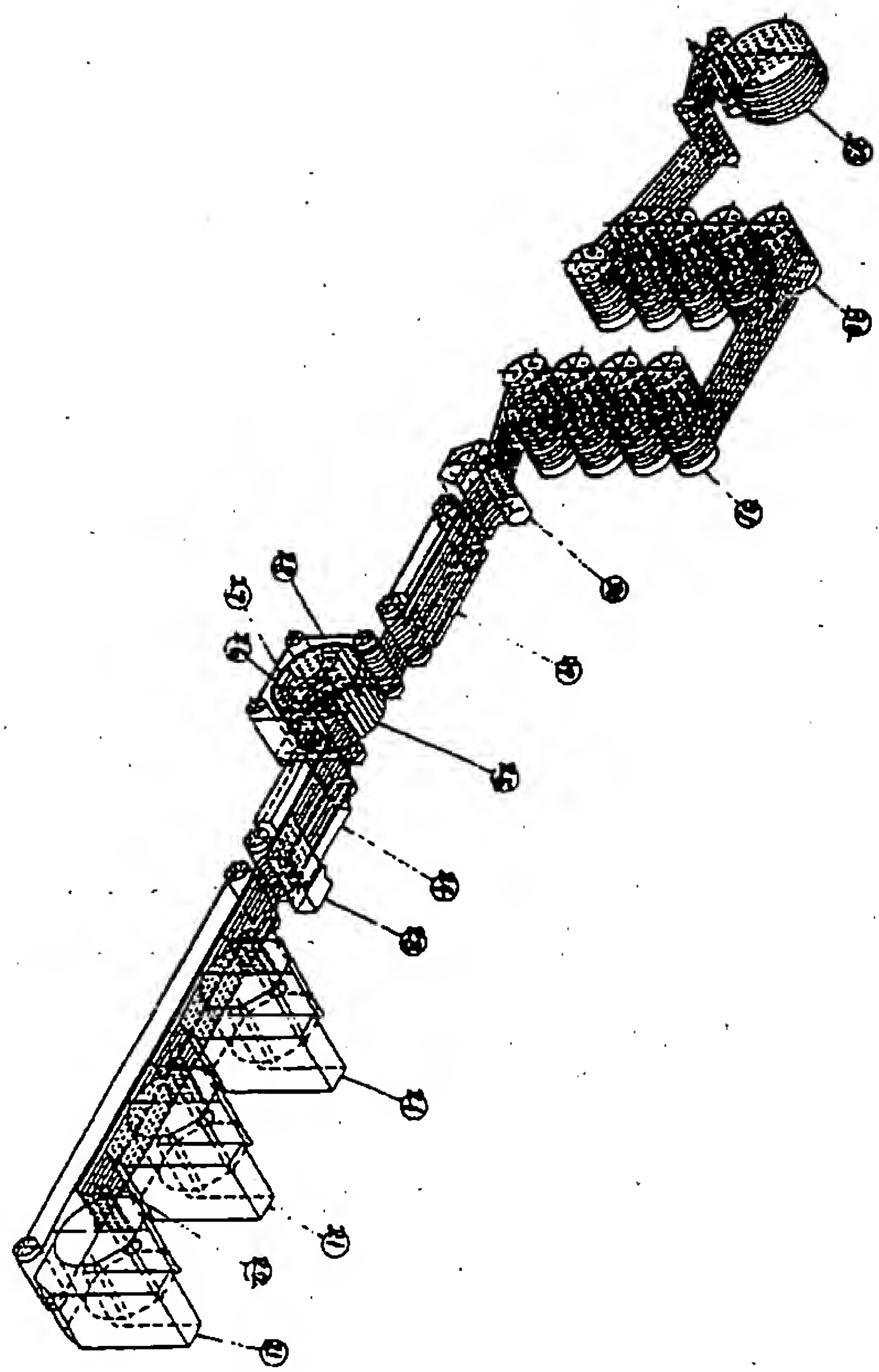
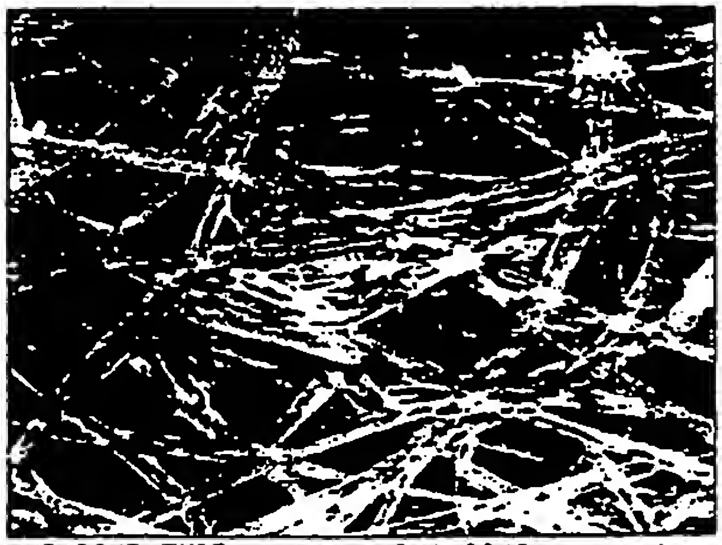


FIG. 2



CHEMBOND TYPE Rayon/PVA 92/8 percent

FIG. 3

APERTURED FABRIC Rayon/PVA 96/4 percent

FIG. 4

PVA BLEND (%) VS WEIGHT NORMALIZED TENSILE STRENGTH

MD DRY STRIP TENSILE - CHEMBOND TYPE FABRIC

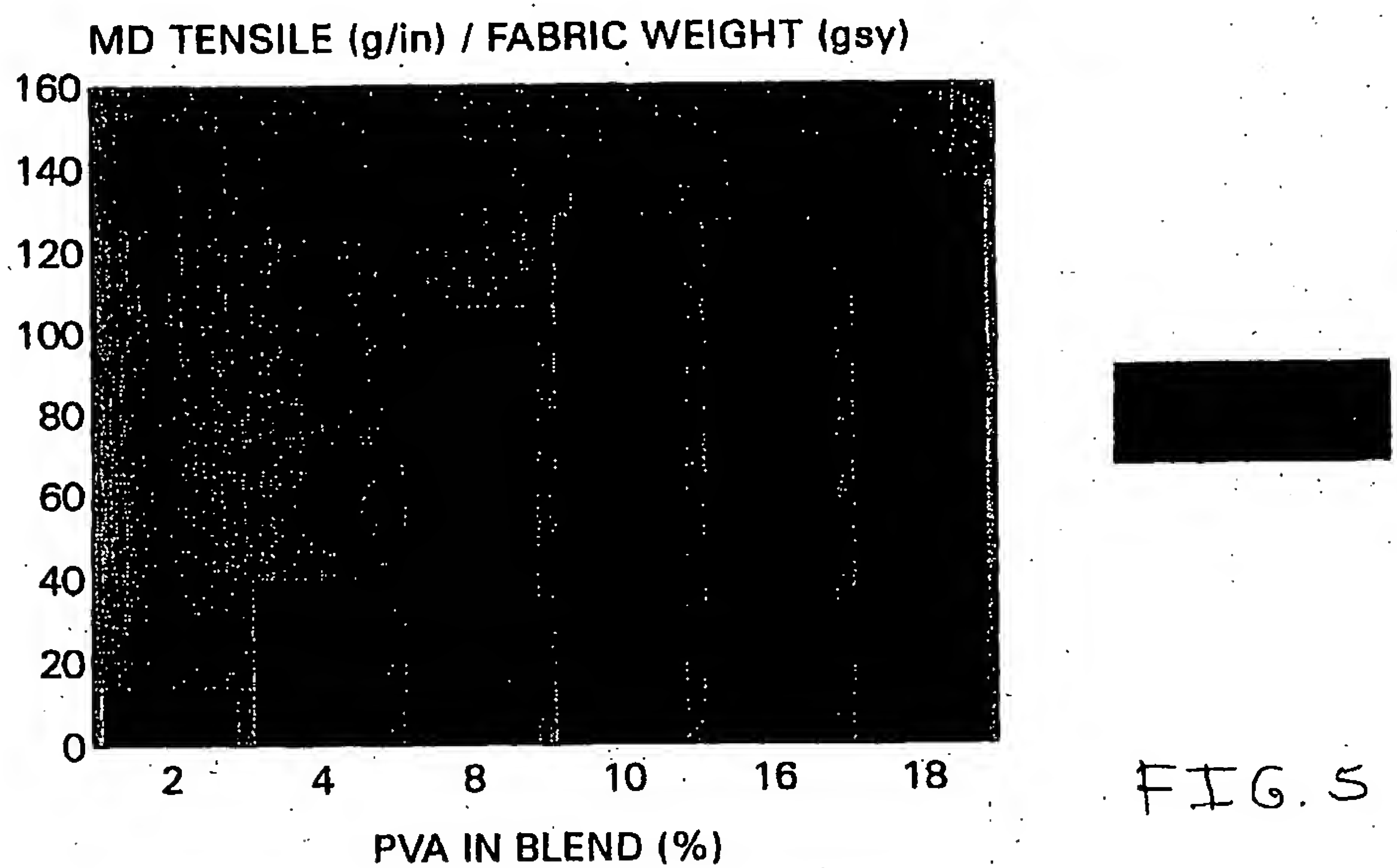


FIG. 5

PVA BLEND (%) VS WEIGHT NORMALIZED TENSILE STRENGTH

MD WET STRIP TENSILE - CHEMBOND TYPE FABRIC

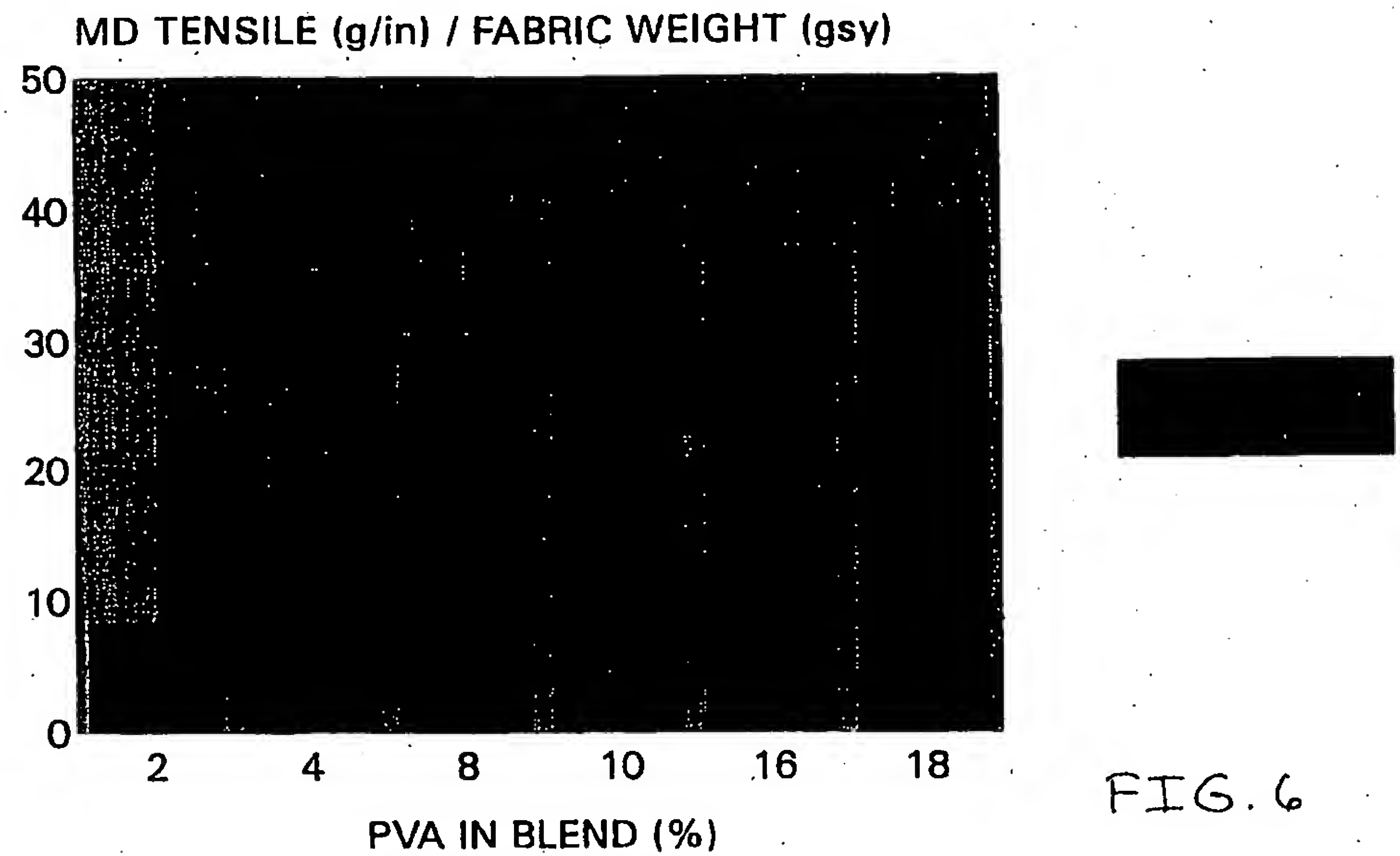


FIG. 6

PVA BLEND (%) VS WEIGHT NORMALIZED TENSILE STRENGTH

CD DRY STRIP TENSILE - CHEMBOND TYPE FABRIC

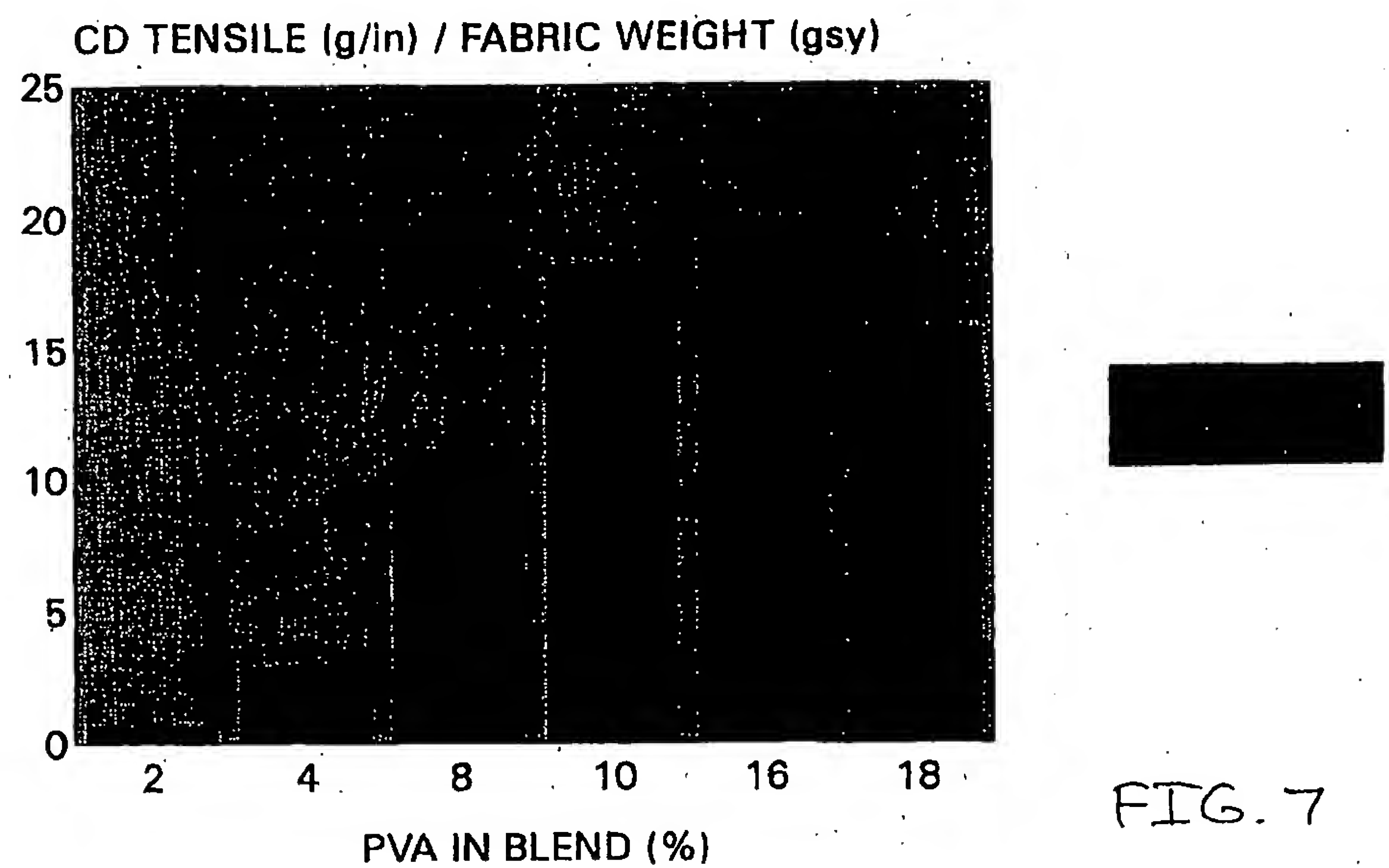


FIG. 7

PVA BLEND (%) VS WEIGHT NORMALIZED TENSILE STRENGTH

CD WET STRIP TENSILE - CHEMBOND TYPE FABRIC

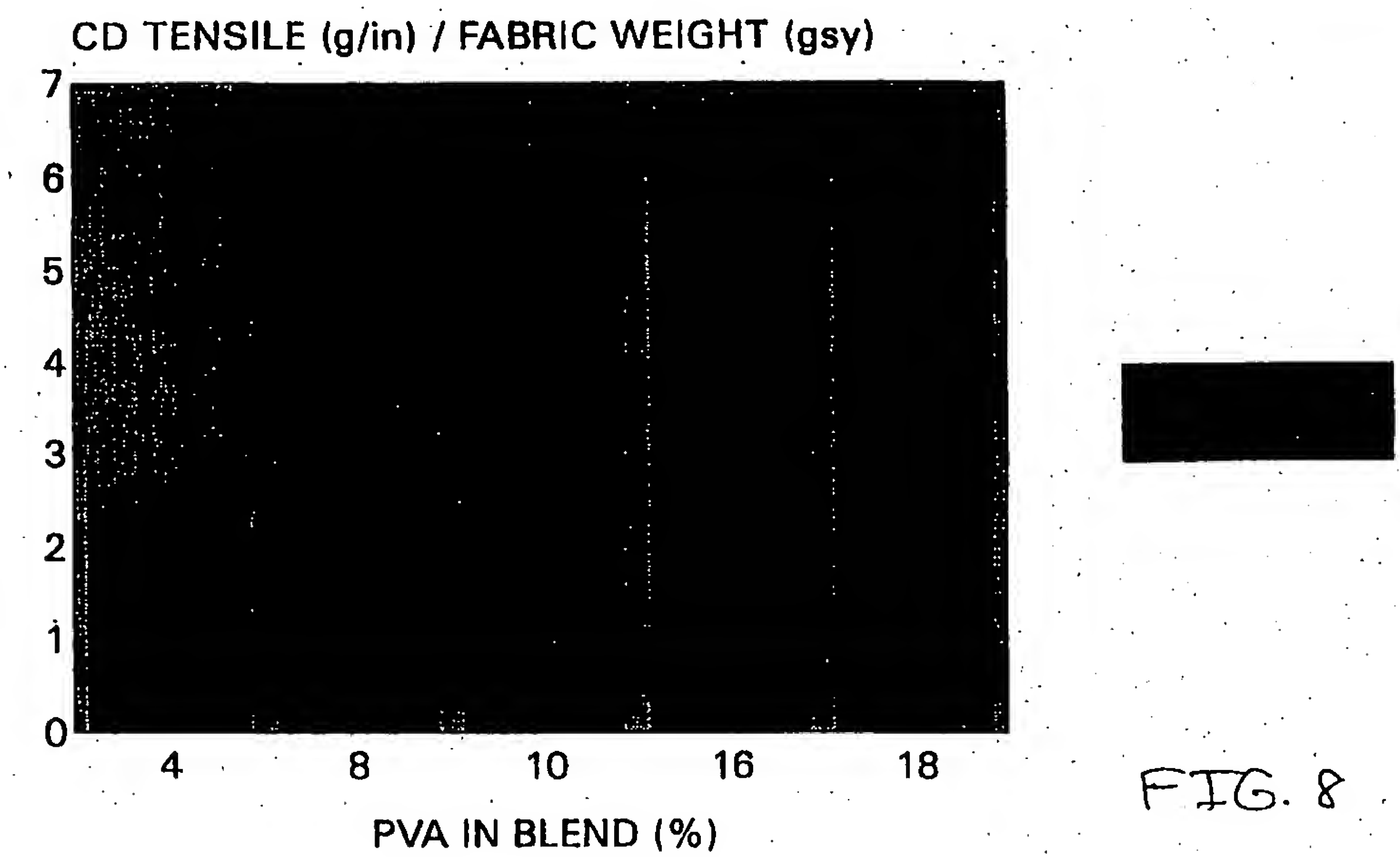


FIG. 8

PVA (%) VS WEIGHT NORMALIZED HANDLE-O-METER VALUES (gm/gsy)

MD DRY STRIP HANDLE-O-METER VALUE - CHEMBOND TYPE FABRIC

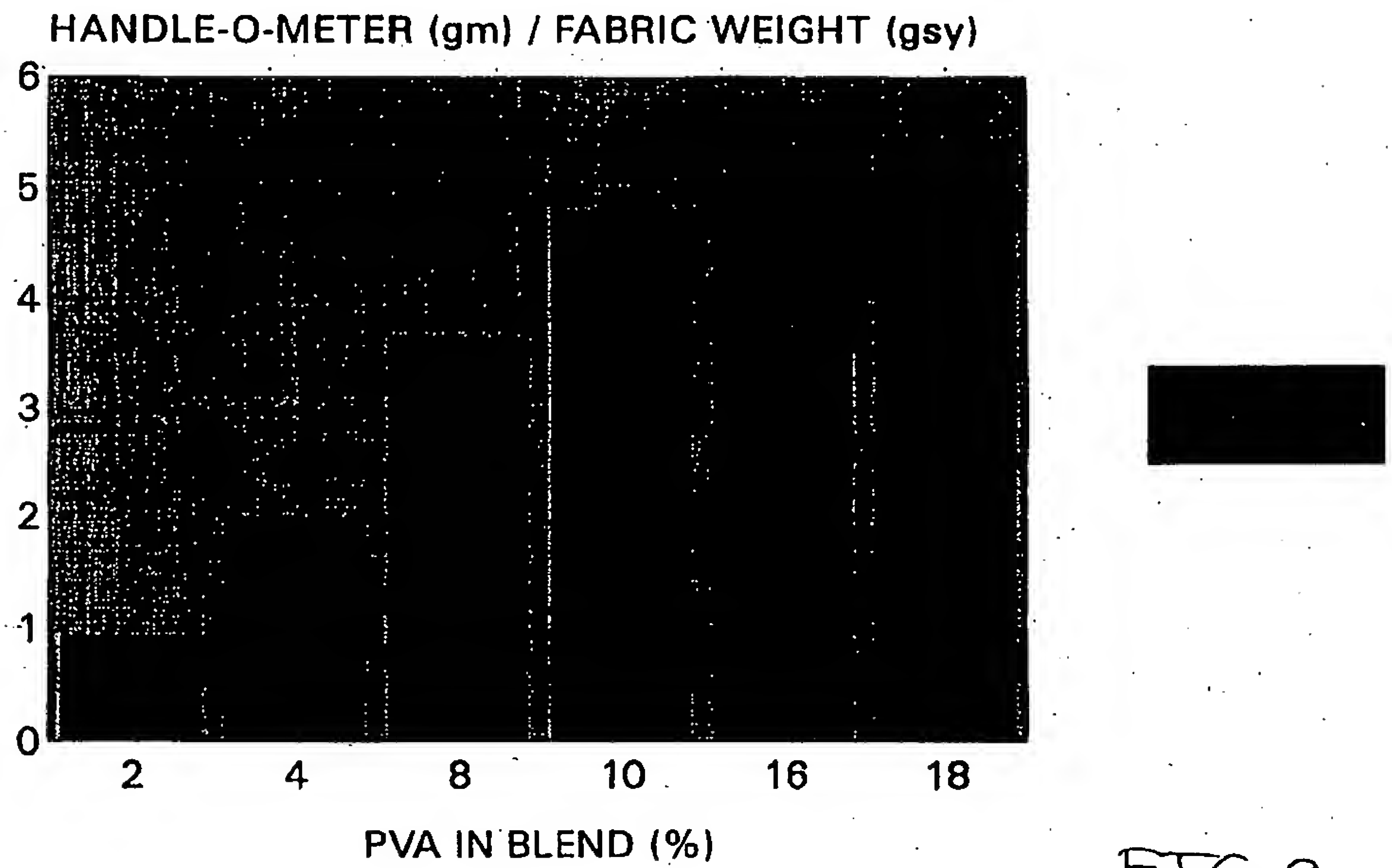


FIG. 9

PVA (%) VS WEIGHT NORMALIZED HANDLE-O-METER VALUES (gm/gsy)

CD DRY STRIP HANDLE-O-METER VALUE - CHEMBOND TYPE FABRIC

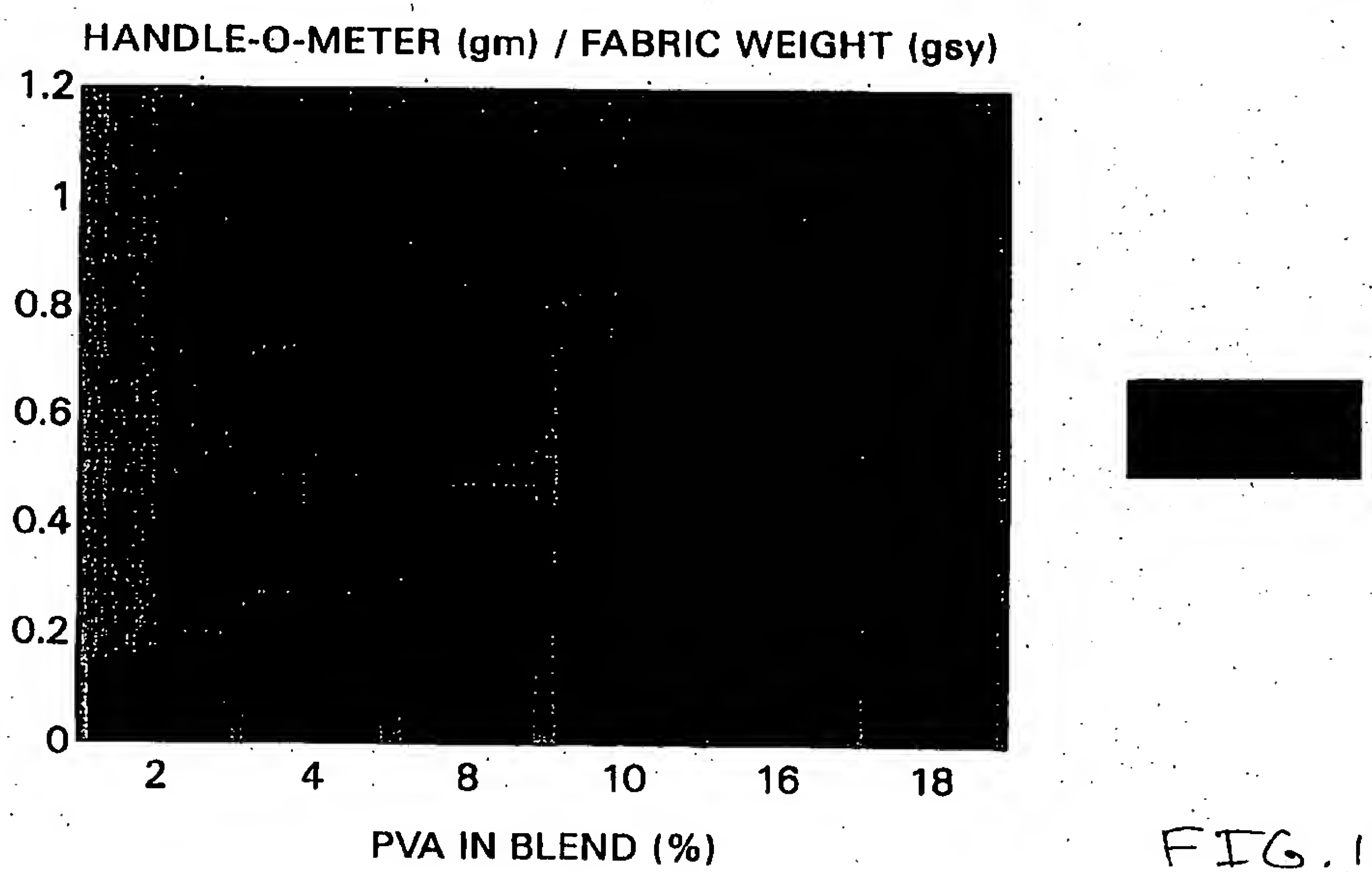
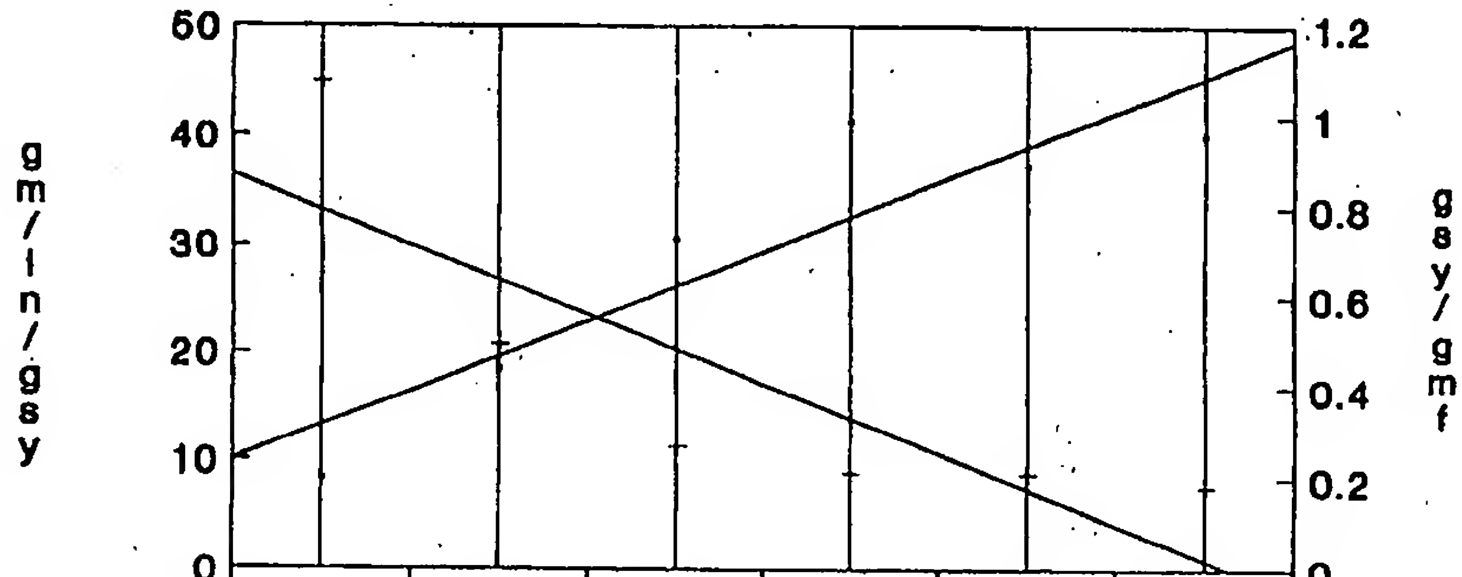


FIG. 10

INTERACTION OF TENSILES & SOFTNESS
MD STRIP - WEIGHT NORMALIZED DATA



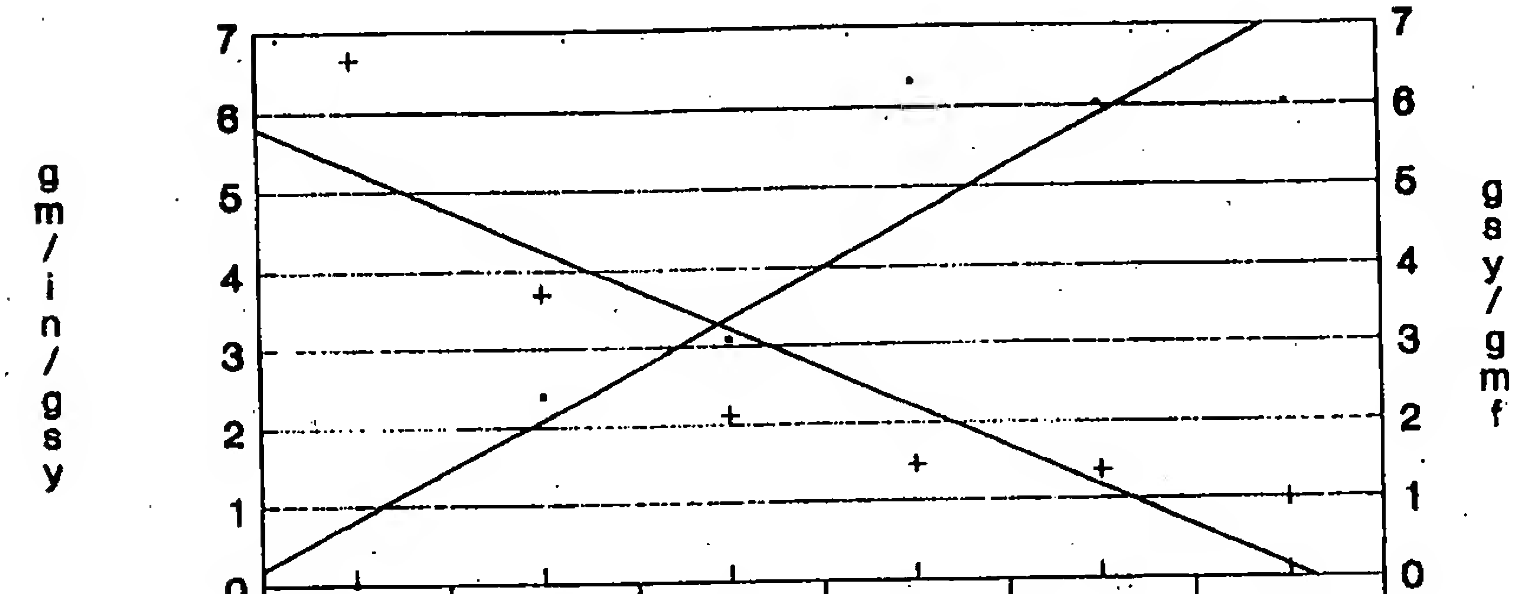
	2	4	8	10	16	18
gm/in/gsy	8.29	18.53	30.44	41.27	37.11	39.97
gsy/gmf	1.08	0.5	0.27	0.21	0.21	0.18

PVA IN BLEND (%)

— gm/in/gsy —+— gsy/gmf

FIG. 11

INTERACTION OF TENSILES & SOFTNESS
CD STRIP - WEIGHT NORMALIZED DATA



	2	4	8	10	16	18
gm/in/gsy	0	2.41	3.09	6.32	6.03	6.03
gsy/gmf	6.67	3.7	2.13	1.45	1.37	1

PVA IN BLEND (%)

— gm/in/gsy —+— gsy/gmf

FIG. 12

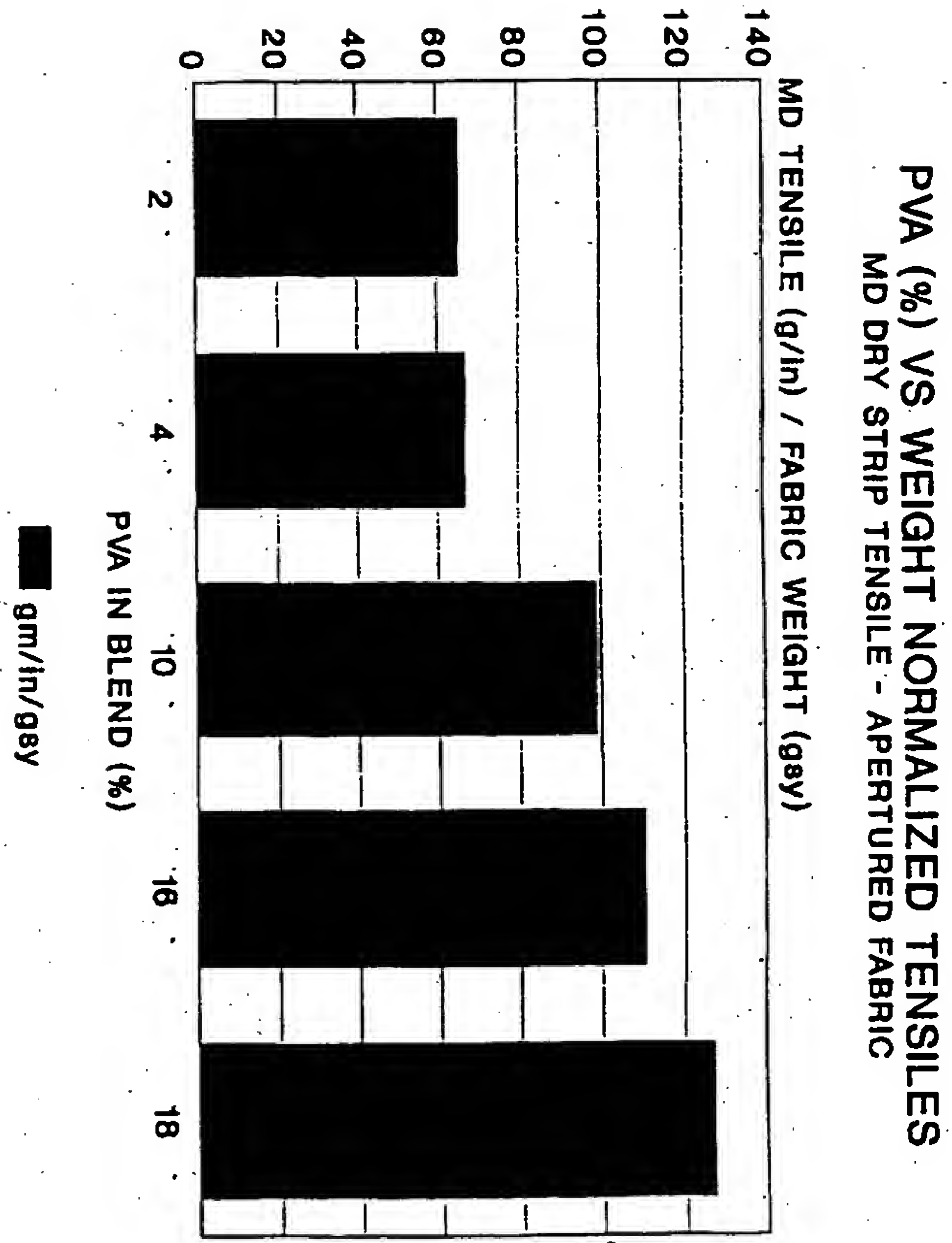

PVA (%) VS WEIGHT NORMALIZED TENSILES
MD DRY STRIP TENSILE - APERTURED FABRIC
MD TENSILE (g/in) / FABRIC WEIGHT (gsy)
0
20
40
60
80
100
120
140
2
4
10
16
18
PVA IN BLEND (%)
gm/in/gsy

FIG. 13

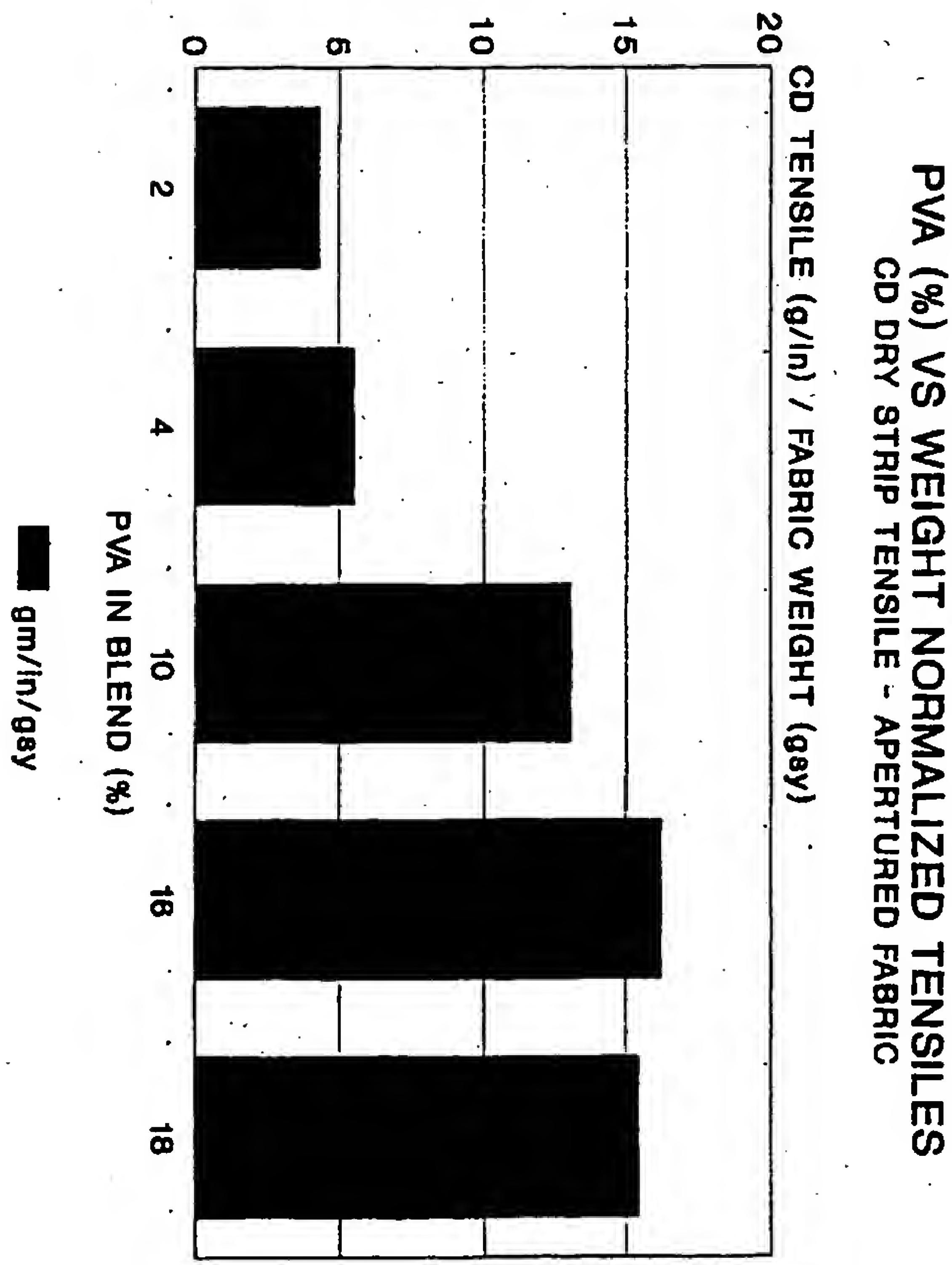

PVA (%) VS WEIGHT NORMALIZED TENSILES
CD DRY STRIP TENSILE - APERTURED FABRIC
CD TENSILE (g/In) / FABRIC WEIGHT (gsy)
20
15
10
5
0
2
4
10
18
18
PVA IN BLEND (%)
gm/in/gsy

FIG. 14

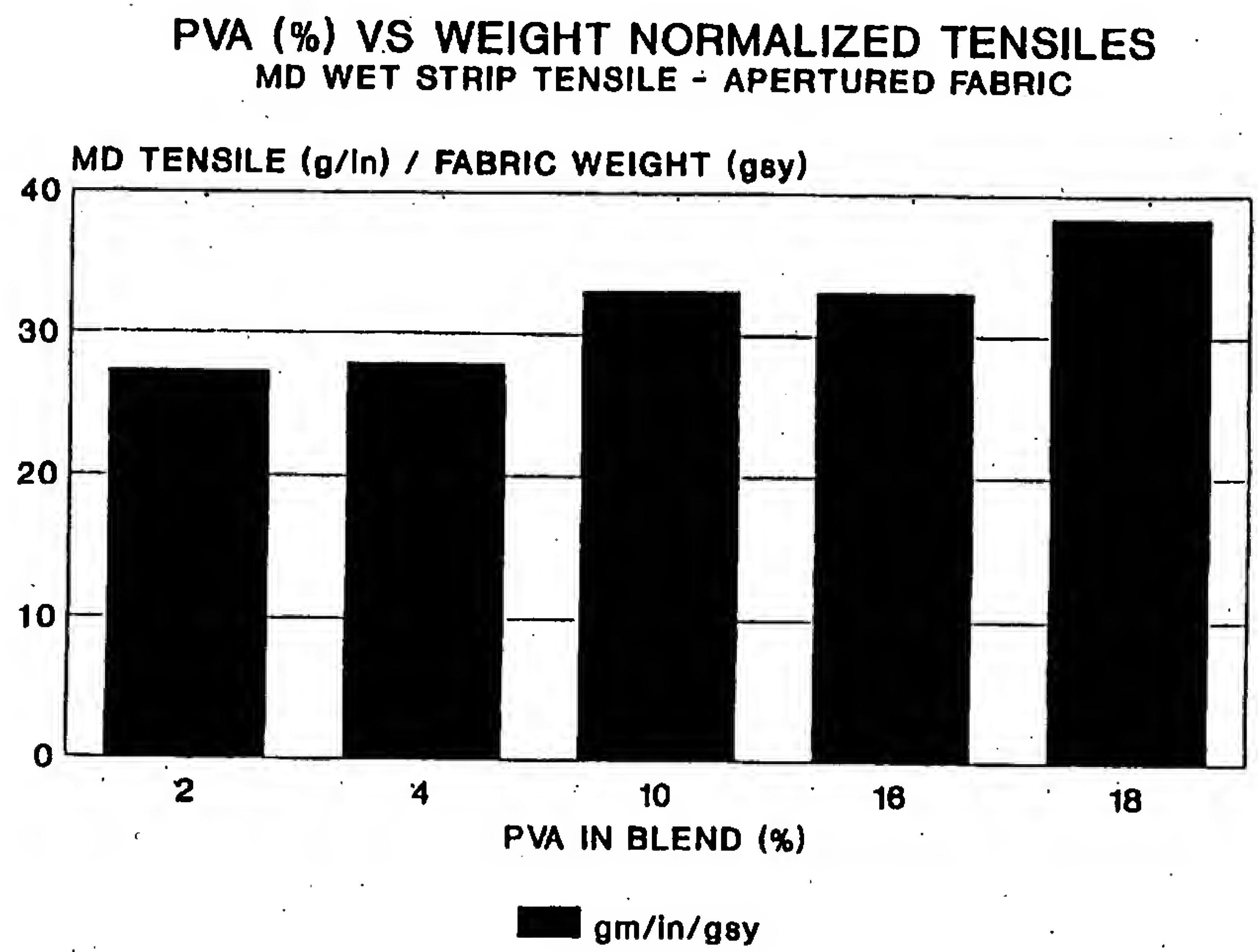

PVA (%) VS WEIGHT NORMALIZED TENSILES
MD WET STRIP TENSILE - APERTURED FABRIC
MD TENSILE (g/in) / FABRIC WEIGHT (gsy)
40
30
20
10
0
2
4
10
16
18
PVA IN BLEND (%)
gm/in/gsy

FIG. 15

PVA (%) VS WEIGHT NORMALIZED TENSILES

CD WET STRIP TENSILE - APERTURED FABRIC

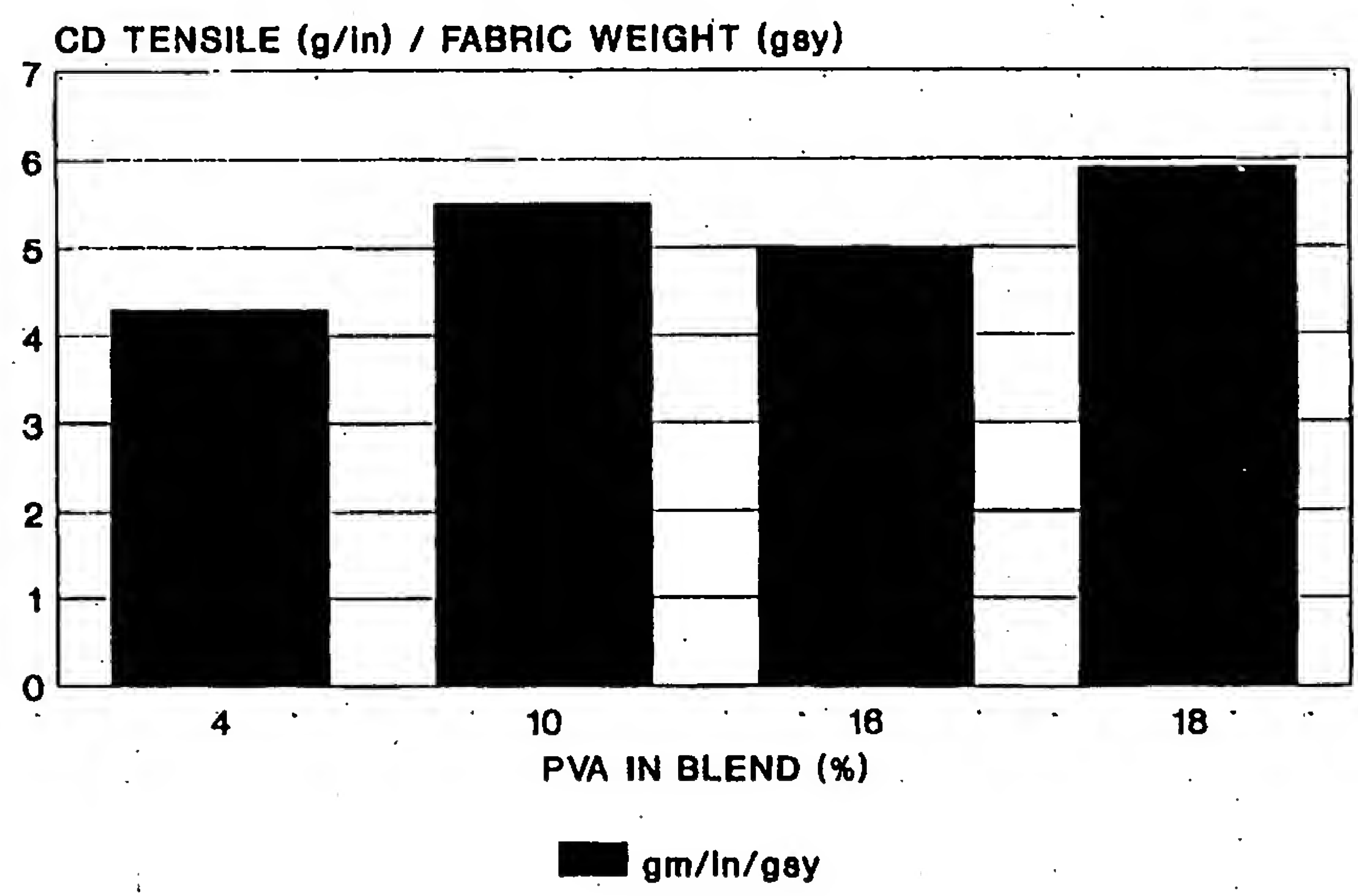
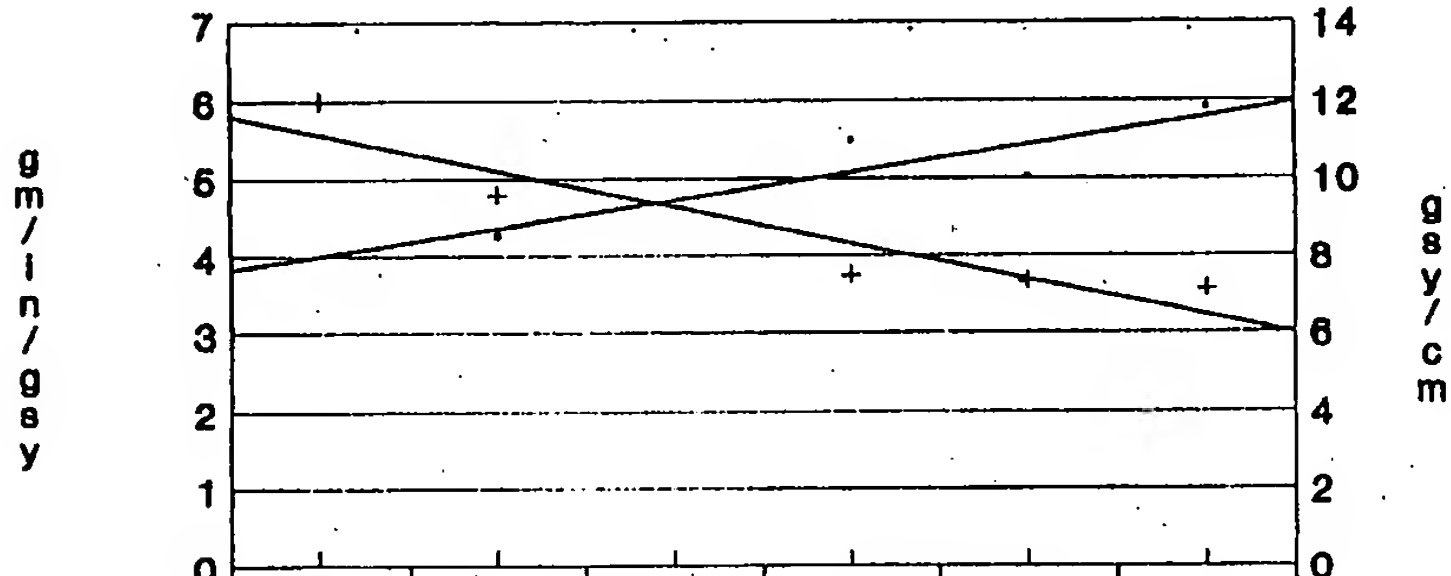


FIG. 16

INTERACTION OF TENSILES & STIFFNESS
CD STRIP - WEIGHT NORMALIZED DATA



	2	4	8	10	16	18
gm/in/gsy		4.26		5.5	5.01	5.91
gsy/cm	11.99	9.58		7.48	7.32	7.14

PVA IN BLEND (%)

— gm/in/gsy —+— gsy/cm

APERTURED FABRIC

FIG. 17